UNIVERSITY OF ALBERTA

Lighting Design Guidelines and Standards

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1 INTRODUCTION

The intent of this document is to indicate and effectively communicate recommended lighting design practices and University expectations. This document should be the basis for the design consultant team to achieve desired goals and principles.

In general, the University's principles and goals are to construct and renovate facilities that are:

- Functional and meet the needs of the users.
- Safe and reliable.
- Consistent with a highly satisfactory indoor environment.
- Institutional quality and provide a long building systems service life.
- Efficient and cost effective for operation and maintenance.
- Designed to provide low operating and maintenance costs for the life of the facility
- Composed of environmentally friendly and recyclable materials

Facilities Management is the steward of the University facilities and is responsible for the operation and maintenance of the facilities in a reliable, efficient and cost effective manner. Facilities Management has recognized several long term operating, maintenance, and cost benefits by using certain preferred system concepts, equipment, and operating procedures. The University has also come to recognize certain systems and equipment components to be problematic and costly to operate and maintain. Considering that a new facility has an expected service life of 25 to 30 years or more, Facilities Management has created design guidelines and other instructive documents to communicate preferred design practices, system configuration requirements, equipment types and features to be selected for use in U of A facilities to the Design Consultant Team for incorporation into the final design.

The following sections are guidelines for design criteria, product selection, and methods for the implementation of lighting systems on the University of Alberta campuses.

These guidelines are to be used in conjunction with professional engineering expertise and professional judgment, and are intended to complement the design and construction standards, guidelines, and processes already in use by the University of Alberta. Consultants remain ultimately responsible for the design, and for ensuring conformance to municipal, provincial, and federal code and requirements.

Existing standards that should be read along with this document include:

- University of Alberta Design and Construction Standards and Guidelines
  Original Posting Nov 2003, for current versions visit:
  http://www.uofaweb.ualberta.ca/pi/guidelines.cfm
- University of Alberta Department of Planning & Infrastructure Technical Services – CAD Procedures Manual Standards for Consultants (Rev. 2004-02-24)
  Current Version:
  http://www.uofaweb.ualberta.ca/pi/pdfs/ConsultantDesignDrawingStandards.pdf
- University of Alberta Standards for Design and Installation of Street, Walkway and Outside Area Lighting (April 2008)
  Current Version:
  http://www.uofaweb.ualberta.ca/utilities/pdfs/Standard_for_outdoor_area_lighting_design_and_installation.pdf
- IESNA Design Guide for Application of Luminaire Symbols on Lighting Design Drawing (ANSI/IESNA DG-3-00)
- ANSI/ASHRAE/IESNA Standard 90.1-2007, "Energy Standard for Buildings Except Low-Rise Residential Buildings" (Visit http://www.ashrae.org/)
- IES Lighting Power Density (LPD) Public User's Manual – August 2005
  (Visit http://lpd.ies.org/cgi-bin/lpd/lpdhome.pl for IES LPD page)
- Illuminating Engineering Society of North America (IESNA) Standards.
- LEED Standards (Visit http://www.cagbc.org/leed/what/index.php for the Canada Green Building Council Website and related LEED information)
- International Dark-Sky Association (Visit http://www.darksky.org/)

Tested innovative ideas and approaches are encouraged, and proven technological advances are recognized as being important to realize economic and functional advantages made possible by such advances. Ideas and approaches that fall into this category must be presented to the University (early in the project design period, preferably in the SD [schematic design] or Pre-SD phase of the project) in writing providing rationale outlining why the innovation would be in the best interest of the University from a functional and/or financial perspective for operations and maintenance of facilities. Approval, if granted by the University, will be provided in writing prior to allowing implementation.

2 PRINCIPLES AND DESIGN GUIDELINES

2.1 Requirement for Luminaire Efficiency

The University of Alberta is committed to energy conservation and stipulates that only luminaires with high efficiency ratings can be used for new construction and renovations. Stringent power density values are specified in order to ensure energy efficient design.

2.2 Minimum Efficiency of Luminaires (Lenses / Diffusers in place)

Each luminaire (with lens in place if one is required by the luminaire design) must meet a minimum efficiency requirement depending on it's type and function.

- Fluorescent = 80% minimum efficiency
- Downlights = 70% minimum efficiency
- Architectural Feature = 50% efficiency

The use of luminaires for architectural feature lighting should be kept to a minimum and power use of these luminaires must be added into the Lighting Power Density calculations done for the space.

See Lighting Products Section 5 and Appendix D for approved luminaires.

2.3 University of Alberta Recommended Power Density Values

Table 1: Maximum Lighting Power Densities

Area / Lighting Type	Lighting Power Density [Watts/Ft^2]	Lighting Power Density [watts/m^2]
New renovation and construction – Interior Areas	0.8 – 1.0	8.6 – 10.8
Walkways, Building facade, and Exterior Near Entrance Areas	0.1	1.1
Parking Area – Indoor Parkades or Surface Lots	0.2	2.2
Low Level Lighting	0.07	0.75
Emergency Lighting	0.03	0.32
Classrooms	0.6 – 0.8	6.5 – 8.6
Offices	0.6 – 0.8	6.5 – 8.6
Laboratories	0.7 – 0.9	7.5 – 9.7
Corridors / Hallways	0.15 – 0.3	1.6 – 3.2

For power density calculations, all connected lighting loads (including ballast losses wth all dimming set at 100%) are to be assumed on unless groups of luminaires are interlocked with other groups of luminaires such that all the luminaires in the both groups cannot be energized at the same time. Some typically accepted exclusions from this calculation are Theatrical Dimming lights and battery powered emergency wall packs.

Refer to IES standards for details on calculating lighting power density values. (See IES Lighting Power Density (LPD) Public User's Manual)

2.4 Recommended Illumination Values & Design Approach

New lighting systems are to provide the lighting performance criteria shown in Appendix A on an area by area basis. Lighting values expected are averaged over the area and are to be maintained lighting values. Use an all inclusive light depreciation factor of 15% for initial values in performing calculations. Lighting levels required from luminaires shall be approximately 15% greater than the Appendix A values to compensate for light depreciation factors contributing to degraded luminaire performance that are expected during typical building operation conditions.

It is generally accepted by Illuminating Engineering Society of North America (IESNA) that illumination in office and general work spaces can be provided by either of the following methodologies. Based on meeting illumination levels of 450 LUX for office work space and 300 LUX for office general space:

- Methodology #1 would consist solely of direct illumination from overhead lighting system. Full illumination requirements can also be met by using direct / indirect overhead lighting systems.
- Methodology #2 would consist of ambient illumination from the overhead lighting system with supplementary task lighting. An ambient level of approximately 300 LUX is provided throughout the space by direct, indirect, or direct / indirect overhead lighting systems. Supplementary task lighting is provided at workstations to increase lighting over task areas to meet the required illumination levels. See Task Lighting section for approved task lighting types and practices.

Lighting measurements are to be taken in typical areas on a random basis on a 1.5 meter grid at task level to confirm performance after the work is complete. Lighting levels for stairwells, corridors and hallways are to be taken at floor level.

2.5 Equipment Quality & Lifespan

The minimum life expectancy for all equipment and components associated with lighting and lighting control to be used in U of A facilities is 25 years. This means replacement parts must be available for this same period of time following installation. The quality of components and assemblies is critical so that the systems retain their structured integrity, pleasing appearance and photometric effectiveness throughout their life. The luminaires

must also withstand the stress of relocation during their life without distortion and misalignment of components.

Luminaires must be submitted for approval if they are not on the Approved Luminaire List - See Appendix D.

2.6 Lighting System Supply Voltages - New Construction and Retrofits

All new building lighting systems are to operate at 120VAC fed from separate / dedicated lighting panelboards. Retrofit work in existing buildings is to utilize the existing base building voltage to avoid confusion for maintenance staff. Linear fluorescent dimming systems (for all new buildings and for existing facilities with 120/208V lighting) must operate at 120VAC. If dimming systems are used in a building with lighting that operates at 347V, the proposed 120V distribution for dimming must be discussed with the U of A maintenance staff for acceptance. New 347V dimming is not approved for use.

2.7 Approved Light Sources & Applications

The following provides general information on approved light sources and applications. For more detailed information on products and applications, including a list of approved luminaires and lamp selections, see the approved products in Section 5 and Appendix D.

2.7.1 *Halogen*

Only MR16 and MR11 lamps are approved for use in this category. This type of light source can commonly be used in recessed downlights or aimable track heads. Suggested applications include feature lighting, dimmable applications, and replacements for warm light sources.

This type of light source should not be used for 24/7 operations.

2.7.2 *Linear Fluorescent*

This should be the most commonly used light source. Preferably to be used with T8 lamps and electronic ballasts with added specular reflectors as necessary. Fluorescent High Output T5HO lighting systems are the preferred alternative to the use of HID lighting where they can meet project design requirements. VHO type bulbs are prohibited from use at this time, but may be considered with written approval (via variance process) as the technology improves. T5HO should be considered for higher ceiling heights or where greater illumination values are required.

2.7.3 *Compact Fluorescent (Plug-In)*

Compact fluorescent light sources are encouraged to be used wherever linear fluoresecnt use is not possible or practical. Twin tube lamps are acceptable. Higher output lamps should be limited to 18, 32 watt triple tube, and 42 watt triple tube plug in type with separate electronic ballasts.

These types of compact fluorescents should be considered for all new projects so that incandescent lamps cannot be used in their place.

However, dimming should not be considered and two lamp 18, 32, 42 watt fixtures are discouraged. Any luminaire using these must be designed to accommodate the lamps in their recommended operating temperature range.

2.7.4 *Compact Fluorescent (Screw-In)*

Compact fluorescent light sources are encouraged to be used wherever linear fluoresecnt use is not possible or practical. Medium base is preferred for screw-in compact fluorescent lamps, but others are acceptable for use in lighting retrofit applications.

2.7.5 *LED*

LED lighting solutions should be considered for any task where it can meet design requirements and its use can be implemented within the project budget. Examples of the effective application of LED lighting are: indoor valence lighting, accent lighting, and exit signage. Task lighting applications must be approved by the university prior to implementation. In selecting LED products for use, ensure that they are backed by a 5 year warranty against failure.

2.7.6 *Induction*

This type of lighting offers very long lamp life and should be considered in locations where it would be difficult to replace or service standard linear fluorescent, HID lamps or associated components. The Philips 85W QL Induction Lighting System lamps are recommended.

2.7.7 *High Intensity Discharge*

Metal Halide lamps should be minimum 70 watt ceramic arc tube type with high colour rendering rating and utilize electronic pulse start ballast technology. Applications include extreme temperature areas where fluorescent lighting may not perform as well.

Exterior HID luminaires are not to be used indoors where they may overheat and shorten component lifespans.

2.8 Restricted or Prohibited Illumination Sources (Use by Special Permission Only)

2.8.1 *Incandescent*

Incandescent lighting should only be used in circumstances such as specialized task lighting, theatrical instruments or in deep freezers. In addition, the Government of Canada is planning to ban inefficient incandescent light bulbs by the year 2012. Details of this plan have not yet been announced, but use of this type of light source should be avoided if possible.

2.8.2 *Cold Cathode*

This type of lighting has been prohibited as it has been found to be unreliable. However, this type of lighting may be approved for use in the future, if it has been proven to work accepatably in a specific application that was comparable to that being proposed.

2.8.3 *Biaxial twin tube*

Also known as U tube and has been prohibited from use in renovations and new construction except by written permission.

2.8.4 *High Pressure Sodium*

Should only be used with written approval, for outdoor applications, or possibly for plant growth illumination.

2.8.5 *T5, T12, and VHO Technology*

These are technologies that are not accepted for use in University Projects. Approval through the variance application process and formal acceptance is required to use these technologies.

2.9 Area Applications

2.9.1 *General Area Lighting*

General area lighting shall be primarily linear fluorescent. Lighting values are to meet power density values specified in Table 1 and lighting levels specified in Appendix A.

2.9.2 *Downlight Lighting*

All downlights shall be single lamp compact fluorescent or halogen types. Select lamps from the approved products Section 5.4. Compact fluorescent lamp types should be restricted to 13 watt and 18 watt twin tube, and 32 or 42 watt triple tube compact fluorescent lamps. Standard incandescent lamps shall not be used.

Two lamp luminaires shall not be used without written variance applications and approvals. Highest efficiency vertical lamp style luminaire designs are to be used.

In spaces that require low profile downlighting designs, designers should consider using shallow MR16 or MR11 halogen luminaires.

Plug-in compact fluorescent lamps shall be operated by single lamp electronic ballast. All compact fluorescent ballasts must be high power factor.

2.9.3 *Direct / Indirect Lighting*

Direct / Indirect lighting can provide an aesthetically pleasing and effective lighting alternative. It should generally be accomplished with linear fluorescent single lamp T5HO luminaires.

This type of lighting is not appropriate for small areas or low ceiling spaces. Luminaires should ideally be hung 18" from the ceiling, and definitely no closer than 12". The minimum ceiling height should be 9', but 10' is preferred. See Appendix D for approved luminaires.

2.9.4 *Accent Lighting*

Where accent lighting is to be utilized for highlighting of poster boards, artwork, plaques or other such tasks requiring intense, directed illumination, the preferred light source is to use MR16 halogen with 10,000 hour rated lamp.

Compact fluorescent should only be used for accent lighting where a wash of light is the designer's intended effect.

2.9.5 *Track Lighting*

Where track lighting is to be used, only Juno or Halo type track is to be installed. See approved products section for various linear T5HO fluorescent track lights and for MR11 and MR16 type heads.

2.9.6 *Service Areas*

Suspended, recessed or surface mounted luminaires can be used for lighting in storage areas, vaults, utility rooms, and staff lounges. Where lamps may be vulnerable to mechanical impacts, wire guards must be utilized. Otherwise industrial style luminaires are recommended.

2.9.7 *Exterior Lighting*

This refers to building mounted or architectural lighting within 10 m of a building. The use of recessed sidewalk type luminaires is discouraged. Same wattage and lamp standards as indoor apply. For luminaires beyond 10 m, see separate University standards.

Exterior lighting shall be provided by luminaires designed for all weather applications and utilizing compact fluorescent and/or metal halide illumination sources. Metal Halide (MH) lamps shall be ceramic arc tube design and sized not less than 70 watt. Refer to separate University of Alberta Standards for Pole Mounted Lighting listed at the beginning of this document.

Full cutoff luminaires (no upward light) are required except by variance approved by the University of Alberta.

Exterior luminaires mounted at ground level must be provided with guards, or mechanical protection to reduce risk of serious damage from accidental contact or vandalism.

Refer to Appendix D for approved building mounted exterior lighting products.

2.9.8 *Task Lighting*

Task lighting is defined as supplementary lighting used to provide illumination on a specific task where ambient light is inadequate for that task. The task may be vertical, of small detail, mobile or for the visually impaired. Task lighting must be included in the total connected load calculation as stated by IES standards: (http://lpd.ies.org/cgi-bin/lpd/lpdhome.pl)

Typical furniture mounted direct task lighting (ie – under cabinet lighting) should be avoided. Typically they offer no individual control, do not put light where it is needed, and create glare.

To offer the most ergonomic benefits, task lights must:

- Be easily moved with one hand
- Be adjustable to reach a wide area
- Remain cool to the touch for burn safety and comfort
- Provide a large footprint of light
- Provide at least an additional 250 lux where documents are being read
- Turned on/off by the user

Portable task lights should be limited to secure areas such as private offices, or secured to the specified location with a security tether. Use energy efficient compact fluorescent or linear T8 or T5HO lamps.

2.10 Low Level Lighting (Night Lighting)

Provide for night lighting in spaces to allow easy and safe passage for those entering the space at night.

Utilize only 4' fluorescent luminaires for night lighting. Linear fluorescent wall washers or direct/indirect lighting fixtures are ideal ways of providing night lighting as they will diffuse low level light over a greater area. Refer to Section 2.3, Table 1 for the recommended power densities for the overall space, and for low level lighting – this will help determine how many luminaires should be night lights.

A minimum of one nightlight shall be included in the following areas:

- Main Offices
- Main Hallways
- Entrance Areas such as vestibules and lobbies
- At switches controlling lighting for large spaces
- Washrooms

In large areas or rooms where light switches for the area are not located near the entrance and or exiting doors, provide for lighting a circulation pathway from the entry point(s) to the switches. This circulation pathway should direct the user along a route that avoids obstacles, furniture, and any other obstructions with space between luminaires used for night / pathway lighting being no more than approximately 6 metres apart.

At least some lights at the entrance/exit of a parkade structure should be night lights.

Low level lighting must meet power density requirements specified in Table 1 (See Section 2.3).

2.10.1 *Stair Tread Lighting*

This refers to a specific type of low level lighting where embedded fixtures are cast in walls near stair treads or in stairs themselves. This would only be recommended for areas where it is important that lighting is confined solely to the stairs such as theatre walkways where it is important for people to be able to exit the space without additional light safely. Another application would be for low level lighting on theatre catwalks during performances.

Exterior stair tread lighting is not recommended.

2.11 Emergency Lighting

Emergency lighting shall be a minimum illumination average of 10 LUX, measured at floor or tread level, in exits and along means-of-egress, and as otherwise required per latest Building Code requirements if its requirements are more stringent.

Emergency lighting should be provided at access to exits, stairwell exits, stairwell exit hallways used by the public, elevator lobbies, elevators, corridors serving classrooms, large storage rooms, service rooms, underground walkways, washrooms and laboratories and as otherwise required by ABC and other relevant codes.

Maximum energy density for the emergency lighting system for a building is specified in Table 1. Emergency lighting can be used in conjunction with the low level lighting system – ie) emergency lighting luminaires can be the same luminaires used for night lighting where practical.

Provide 2 level stairwell light with occupancy sensors controlling a minimum 50% of the light (supplied from standard Utility source). Provide a fire alarm system relay to bypass the occupancy sensors to bring light up to 100% upon alarm. Where stairwell lighting is

provided by a 50/50 blend of utility powered and emergency (voltage provided by an emergency generator) powered luminaires, the 50% of luminaires backed by the emergency generator shall not be controlled by the occupancy sensors.

Designer shall provide DC battery backed emergency lighting units for emergency generators amd associated equipment and in electrical service rooms and vaults as required by relevant CSA Codes, the ABC and as called for elsewhere in the U of A Design Guidelines and Construction Standards. See beginning of this document for a link to this UofA standard.

2.11.1 *Exit Lights*

Exit lights must be placed in all locations required by applicable codes. See Lighting Products Section 5 and Appendix D for approved exit lighting luminaries.

3 CONTROLS

3.1 General Requirements

The lighting control system(s) for a project shall be designed with an understanding of the Owner/User's operational requirements and functional needs for the building and the spaces within it. Lighting controls shall provide a straightforward, cost effective means of reducing energy consumption and maintenance costs. A number of lighting control schemes are available to the designer to meet the end result, each realizing a different degree of control. A careful selection of the appropriate control scheme(s) to be employed should be made to create a system that is both simple to operate and to maintain. Control systems should be designed to accommodate current and foreseeable needs. This implies spending an appropriate amount for expandability and future-proofing the design in order to accommodate evolving technologies. Many current lighting control needs can be met by simple sensors working in isolation (for example, an occupancy sensor in a classroom or in a washroom). More complicated control needs, including sensor sharing, load monitoring, and load shedding, necessitate an integrated system.

The requirements of the control system must be defined at the schematic design stage of the project and the topology and location of the key equipment must be presented for approval by the UofA Operations and Controls before design development begins. The related cost benefit analysis for various alternatives will be part of the schematic design presentation.

Metering requirements for LEED expectations must be defined and selection made on method used at the schematic design stage.

System topology shall be selected that permits revisions to be made without having to make major changes to cabinets and conduit systems.

Control devices are to be located in mainly in electrical rooms or closets. Control components must be accessible. Locating dimming controls or other components that need to be accessible in high ceilings is not acceptable.

Prior to developing a lighting design, a report confirming the fundamental requirements of the system shall be presented for approval at the Schematic Design Phase. The financial totals in the report shall include a figure equal to 20% of the total capital cost of the installed lighting control system as a sum to allow for full 3rd party commissioning and verification. The energy saving cost calculation cannot be based on a lighting system design that has an installed lighting power density that exceeds 0.8 watts per square foot unless a variance is granted by the U of A in writing. Lighting power densities shall be calculated according to IES standards.

All rooms are to be fitted (at the minimum) with either manually operated on-off switches and/or occupancy sensors to reduce energy consumption the use of and quantity of these will dependant on the controls system(s) and strategies selected.

There are several categories of lighting control complexity, and which one to utilize must be decided early in the design process considering multiple factors including, but not limited to, long term support for the system, capital and operational costs, expandability

and sustainability viewpoints. Regardless, the level of lighting controls should be justified before a decision is made. All new constructions should employ one of three categories of control systems for building energy management:

- Basic – The basic level of controls will not include the installation of a Intelligent Automated Lighting Control System and rooms are typically controlled on a room-by-room basis. The use of photo or occupancy sensors is still recommended where they can cost-effectively save energy using a functionally sound design. Most commonly simple wall switches will be utilized for lighting control.

  Occupancy sensors should be widely used to turn all lights off (excluding emergency and night lights) when a space is not in use.

- Intermediate – Intermediate controls will involve the use of a Intelligent Automated Lighting Control System or Low Voltage Relay Panels. However, the configuration / scale of the system being considered should balance the cost of installation to maximize the expected energy savings and calculated payback period. Calculations shall be based upon the final proposed lighting power densities and current University energy rates. Occupancy sensors should be widely used to turn all lights off (excluding emergency and night lights) when a space is not in use. Lights should still be controlled on a zone basis and should not have individual control implemented. Some additional energy savings may also be realized if Intelligent Automated Lighting Control System are used, providing occupancy information to the BAS system that will be used for the efficient control of mechanical equipment and systems.

- Advanced – Advanced Lighting Controls will further develop the measures implemented under the Intermediate level of controls with greater sophistication in sensors, control equipment and information processing. Differences are listed as follows: This category of control will likely prioritize energy savings and sustainability initiatives over initial capital cost to achieve the maximum amount of energy savings. Lighting System Control will be scaled based on project requirements for the facility as a whole or for rooms, areas, up to and including the level of control of individual fixtures instead of zone control. Occupancy sensors will likely be more widespread, when compared with Intermediate levels of control. Justification for this level of controls will likely come from goals based on LEED certification or other similar green building initiatives.

3.2 Intelligent Automated Lighting Control Systems

More advanced lighting control systems employ centralized and/or distributed control over a variety of passive or active illumination sources. Typically one component of the automated or intelligent lighting control system are computer processors. The main system processor can be located inside of a lighting control panel and/or in an external PC. The system intelligence processes data and signals that can originate from occupancy information, photo cells, weather stations, data bases that incorporate dawn and dusk times, dimmers, etc. The same system(s) will process data & signals from: switches, dimmers, occupancy sensors that are located throught the facity as well as input from the Building Automation System (BAS) in order to control lighting and other devices such as window shades. Intelligent processing of exterior and interior signals allows dynamic adjustment of luminaire lighting output via feedback from suntracking/photo sensor coupled with other energy saving techniques to permit daylight

harvesting. Complex, reconfigurable, user defined logic, and other algorithms can be employed to interpret control signals and affect lighting control in defined zones throughout a structure and setpoints for equipment can be more easily adjusted to suit user needs.

A decision on the method of control and the complexity of controls shall be made for all new construction and retrofit projects following a cost benefit analysis at the schematic design stage and submitted to the University of Alberta for approval. This analysis must be based on an efficient lighting design normally designed to run at 100% on for specified illumination values. The type(s) and scope(s) being considered shall be justified based upon return on investment and any other mandated project requirements. Prior to designing a system user and maintainer input shall be solicited, the feedback received shall be recorded in detail as a part of the basis for design and for the project record.

Systems utilized must be able to interface with the UofA Building Automation System (BAS) using BACnet or Lonworks. Future work should be open to a competitive bid process with multiple vendor solutions available for new construction.

If an Intelligent Automated Lighting Control system is utilized, it must communicate with the BAS via BACnet or Lonworks unless a variance is granted that relaxes this requirement. Lighting control system interfacing with mechanical systems control (BAS) shall not achieved using hardwired interlocks. Communication will be via an interconnecting data bus and signals shall be transmitted through the accepted software protocol to and from the (BAS). Part of the contractor scope of work shall be to provide all necessary integration software, labor, hardware needed to produce a fully functional lighting control system. Specifications must include this requirement. The design consultant team shall provide a project specific design document/matrix which identifies the specific logic and control required and information to be sent to the BAS from the lighting control system and from the |Lighting Control System to the BAS.

Wireless communications for controls on campus are not recommended. If the lighting designer feels there is a significant cost savings or other advantage to using this type of technology, formal written approval from the University must be requested.

During a loss of AC power to the control system or voltage sag, the control system must retain all of the features and previous settings without the requirement of human interaction.

At this time, DALI systems are not approved.

Industry standard spreadsheets must be used to develop the expected control results of each and all areas of a building. The Lighting Control Association are to be used for the purpose of creating an easily understood document that follows through to the commissioning and turnover of the Integrated Lighting Control System.

3.3 Low Voltage Relay Cabinets and Systems

These systems offer an intermediate level between simple manual controls and intelligent automated lighting control systems.

These cabinets shall be supplied with complete typewritten relay schedules.

All LVRCs must be located in electrical rooms or closets and not accessible to the public.

3.3.1 *Specifications*

When designing a controls system, clearly worded specifications are an essential final deliverable. They must include clearly worded design intent for the control system and specify commissioning requirements. The responsibility of every task related to the control system must be identified.

3.3.2 *Provisions for the Future*

Components making up the "backbone" of all control systems such as relay cabinets and centralized microprocessors must be located in dedicated closets or rooms with sufficient space for additional future expansion. A reasonable expectation for future expansion is considered to be 30%. This should allow for possible technology change. Relay cabinets should have 10% spare relays in place not used at time of commissioning and 20% space for future additional relays. Integrated lighting systems should have the capability of adding 10% more devices on a "loop" without the need for extending new data cables and the "backbone" should have 20% spare capacity for expansion.

Wiring between electrical closets and rooms must run in raceways with 100% spare raceway space for the future. (e.g. – one full 2" conduit is required, provide a second conduit for future consideration)

3.3.3 *Metering*

Metering can be achieved by either providing transducers at the lighting panels that provide input signals to the BAS or by having the software of an addressable system (such as Encelium) collect and document the data. The transducer method is preferred.

3.3.4 *Emergency Power & Operations*

All devices shall fail or return to "ON" mode such that emergency lighting is on in the event of a power loss.

Devices to be CUL certified for connection to a system providing emergency lighting.

When system returns to normal power, all devices must automatically return to their programmed settings without the need for human interaction.

All controls requirement a power supply should be connected to an essential power source that is not interrupted when the emergency power system is undergoing scheduled interruptions.

3.3.5 *Typical Control Devices for Specific Building Applications*

	Strategy									
Space Type	**Wallbox Occ. Sensor**	**Ceiling/Wall Occ. Sensor**	**Personal Occ. Sensor**	**Timer**	**Time Clock Device**	**Multilevel Switching**	**Manual Wallbox Dimmer**	**Wireless Remote Dimmer**	**Photoswitch**	**Photosensor**
Assembly & Light Manufacturing			○		•	○			○	•
Auditoriums		•				○	•	•		
Classrooms		•				•	•	•	○	•
Concourses, Lobbies, Malls					•	•			•	•
Conference Rooms	○	•		○		○	•	•		•
Exterior Lighting		○			•	○			•	
File/Storage Rooms		•		•						
Grocery/Supermarket		•		○	•	•			○	○
Gymnasiums		•				○			○	
Hallways		•			•				•	○
Laboratories		•	○			○	•			•
Library Reading Areas		•			○	○				•
Library Stacks		•		•	○	○				
Locker Rooms		•			○	○				
Lunch/Break Rooms	○	•		○		○			○	
Medical Suite/Exam Rooms	○	•				•				
Museums		○				•	•		○	•
Open Offices		○	•		•	•	•			•
Private Offices	○	•	•		•	•	•	•		•
Restaurants					○	•	•	○		○
Restrooms	○	•		○		○				
Retail Sales Area					○		○		○	○
Warehouse		•		○	•	•			○	○

• = Good Application ○ = Limited Application

3.3.6 *Dimming & Multilevel Switching*

Multilevel switching is more cost effective to maintain. Lighting controls for areas requiring various lighting values should have a minimum of 2 levels of on/off switching and a 3rd variable level to achieve lower end illumination value requirements. This lower dimmable level is best achieved using halogen MR16 or MR11 lamps.

Where master-slave wiring is used along with multilevel switching, master slaving should be done across lengths of the room with rows of lamps, instead of rows of luminaires. This provides more even distribution of light between levels of switching.

In areas where emergency luminaires may be dimmable, such as in theatres, these luminaires must be setup such that they return to 100% brightness in the event of a fire alarm or power loss.

3.3.7 *Manual Controls*

This is the oldest and simplest method of lighting control. Acceptable manual controls are low voltage switches, line voltage switches, and local dimmers. Manual control systems do not include timers, occupancy sensors, or other energy saving measures. In general, the use of multi-level switching should be considered instead of total area dimming. Multi-level switching is more cost effective to maintain and should be used where it can satisfy usage requirements of the space. Areas where total dimming may be preferred would be for special effects or small rooms requiring less than 6 luminaires.

Pilot switches (switches with a small built in light source showing switch position) should be used in areas where it is extremely dark before lights are activated near the switch, or in areas where it may be useful to know whether lights are on without looking into the space (eg – freezers).

See Lighting Controls (Section 7) for approved manual control products.

3.3.8 *Occupancy Sensors*

Occupancy sensors are to be used in intermittently occupied areas such as classrooms, washrooms, supply closets, photocopy/fax rooms, and parking garages. Systems are to be configured with lighting being turned on either manually or by occupancy sensors and turned off by the sensor after a suitable delay (typically 10 or 20 minutes) has elapsed without any occupancy being detected. Many manufacturers offer adjustable time delays on occupancy sensors before lights are turned off. Designers shall either specify a standard delay to use or specify room specific delays if desired. If possible, time delays should be reduced during off hours as spaces may simply be patrolled by security or walked through by cleaning or maintenance staff.

Self-calibrating or “smart” sensors require little or no adjustment of sensitivity and time dellay settings. Microcontroller monitors space for patterns and automatically adjusts. In the beginning, false-OFF triggering may commonly occur until pattern is established.

Occupancy sensors may also be used in stairwells to maintain lower lighting values when the stairwells are not in use. However, all stairwell luminaires must be configured to turn on upon activation of the fire alarm system if occupancy sensors are used in stairwells. A bypass to the occupancy sensors should be activated by the fire alarm system. Where stairwell lighting is provided by a 50/50 blend of utility powered and emergency powered luminaires, the 50% of emergency powered luminaires shall not be the portion controlled by

the occupancy sensors – the preference would be to leave emergency fixtures unswitched where ever possible.

Select sensor or multiple sensors with sufficient coverage area to leave no "dead zones" in the detection areas; utilize multiple sensors as needed to provide sufficient coverage. As a general rule, ensure control coverage overlaps by 20%. If there are partitions greater than 48" high, de-rate sensor range by 50%. Sensors can be networked.

Where used inside of typical rooms - Sensors are to be wired to provide "auto off" only; the "on" action for lighting control is to be by manual or low voltage switches. Care should be taken in larger spaces where occupancy sensors have off control to allow either enough low level lighting for an undetected user to return to the light switches area, or a flick-warning before lights are turned off to allow a user to abort the lights shutdown.

Acceptable occupancy sensor technologies include PIR/microphonic dual technology sensors or single technology sensors such as either Passive Infrared Radiation (PIR) or microphonic in special circumstances. Such circumstances may include rooms that are highly obstructed where direct line of sight detection is not useful. The main advantage of using this type of single technology sensor would be cost. Sensors that use ultrasonic technology are to be avoided because of their potential for interference with pacemakers and some electronic lab equipment. In general, microphonic detection is superior to ultrasonic technology in that it provides better and more reliable occupancy detection performance, requires less power, and is acoustically passive. Microphonic technology transmits no sound waves into a space, thus eliminating all potential for interference.

Avoid using microphonic or dual technology occupancy sensors in large multi-zone areas where sound will carry (such as in parking garages, etc.), as this could result in unintended/undesirable operation of area lighting and control equipment. If occupancy sensors are desired for such areas, PIR technology should be utilized.

Sensors and any interfaced intelligent lighting control components outputs shall fail to the "ON" position so that lights are not disabled by a failed occupancy sensor or ancilliary interface device.

Designers should:

- Use PIR in enclosed spaces
- Create zones controlled by different sensors to control large areas
- Use dual-technology sensors for areas with very low activity levels
- Install sensors on vibration-free surfaces

Designers should not:

- Install PIR sensors so that their line of sight continues beyond doorways
- Install sensors within 6ft of HVAC outlets

3.3.9 *Photocell Sensors*

Photo Control over Interior Lighting

Photocell sensors are to be used in any areas where daylight harvesting is practical to control using PEC devices. Photocell sensors are to be of an adjustable type and must be equipped with a built in cloud or shadowing delay adjustable up to a minimum of a half hour to reduce nuisance operation switching.

Wherever possible, in areas where daylight is contributing more than 30% of the measured task lighting as measured at 10 a.m. through to 2 p.m., the lighting control system for the space is to be interfaced with appropriate photo control devices to realize the energy savings that are possible. Depending on the area in question, staged drop out of luminaires, dimming, or bulk de-energization of luminaires can be used in response to photocell readings. Areas where a particular illumination level is required such as an office, should use dimming where as areas such as a large attrium, gym, or public space with access to daylighting should consider photocell based switching.

Interface PEC controls with the University of Alberta BAS system for time of day shutdown on a floor by floor basis, two zones per floor. In general, provide *open loop photocell control logic* in public areas. Use *closed loop photocell control logic* in offices, meeting rooms, or classroom areas where shading will affect lighting values.

Closed loop sensors should be placed approximately 2 times the window height away from the window. For example, if the window is 4 feet tall, a ceiling mounted photosensor should be mounted 8 feet from the window/wall.

Photo Control over Exterior Lighting Systems

All exterior building luminaires are to be photo controlled by a single photo control sensor with an adjustable set point between 10 LUX and 50 LUX. The photo cell is to be aimed north and clear of artificial night lighting sources.

All exterior lighting is to be LV relay or contactor controlled not using addressable modules. The contactor or relay system is to be fitted with lockable hand-off-auto selector switching and all located in an electrical room or closet.

Where practical, interface all exterior PEC controls with the University of Alberta BAS system for time of day shutdown.

3.3.10 *Time Control*

The control system shall be used to accommodate time control of most areas, such that the high level lighting can be “swept off” at a predetermined time at night. A warning signal in advance of this should be considered.

3.3.11 *BAS Interface*

A provision should be made to interface control of any given space with available outputs from the BAS system.

At the schematic design stage, lighting designers are expected to interface with the BAS group to develop the interface expectations and define and document the following control requirements:

- Time of Day Control
- Metering
- Centralized multilevel PEC Control
- Hardware Requirements

3.3.12 *Vendor Support*

Before submitting a proposal to be considered, a potential vendor or proponent must demonstrate that they have local representation for the support of parts and service following construction and skilled service technicians are available in the province of Alberta.

Spare parts are to include computer based equipment, all interface modules, and low voltage relays.

The vendor is to be fully responsible for interfacing the control system with the BAS of both the specified building and the UofA main BAS system.

3.3.13 *Controls Drawing Standards*

Designs for control systems must be represented on project specific drawings (that have been correctly formatted per U of A Drawing Standards. The proposed location(s) of all system equipment, components and devices shall be shown. A submission package for a lighting control system that consists of shop drawings and/or of components cutsheets alone that has been received from a manufacturer/representative or agency will not be found acceptable and will be returned for resubmission. Items required for a final submission of shop drawings include device locations, mounting details, interconnection details (ie riser diagrams and data bus locations), and component cut sheets. Preliminary submissions can be made with only some of these details during the schematic design phase of the project.

All details including programming, functions, relay scanner input/outputs, photocells, etc are to be recorded and documented as part of project record.

3.3.14 *Commissioning*

The following commissioning philosophy has been adopted from the Lighting Controls Association (LCA), and can be found on their website at www.aboutlightingcontrols.com.

Commissioning the lighting control system is often a critical component of the design and installation process, and can distinguish whether a project will succeed or fail. Commissioning can help ensure proper equipment operation, user acceptance and intended energy savings in both new construction and renovation projects.

Commissioning is defined as a systematic process of ensuring that all building systems perform interactively according to the documented design intent and the owner's operational needs. This can include factory start-up, sensor calibration and owner notification of the operation and intent of the control systems.

Before commissioning: Optimal commissioning occurs when it is planned and budgeted. The system's designer should provide a controls "narrative" that describes the functionality of the control system, details the commissioning requirements in the project specifications, and includes a sequence of operations for each control point.

Factory start-up: Factory start-up occurs prior to the commissioning process and entails the manufacturer or its representative ensuring that its products performs as intended within the designed system. Factory-startup is also considered the first step in calibration.

Field calibration: Calibration entails adjusting sensors, such as occupancy sensors and photosensors, so that they operate properly within actual field conditions.

In the case of occupancy sensors, the factory default settings (time delay and sensitivity) can be tuned to application conditions to ensure proper operation and expected energy savings. For example, a small difference in the time delay setting can translate to a significant difference in energy savings and lamp life, while a small difference in the sensitivity setting can make a significant difference in whether the lights are activated only when the space is occupied, and deactivated only when it is unoccupied.

In the case of photosensors, the sensor must be calibrated according to field conditions. For example, a photosensor in a room with light-painted walls will respond differently than a photosensor in a room right next door with dark-painted walls. This small difference in application conditions can make a big difference in controls system performance and energy savings for the owner.

In older systems, sensors are calibrated mechanically. In newer systems, sensors may be calibrated using software.

Field commissioning: Commissioning should involve all members of the design and construction team and is typically led by the commissioning agent, who may be an electrical contractor, commissioning specialist, manufacturer technician or some other professional.

Field commissioning requires systematic testing of all controls in the building to ensure that they provide specified performance and interact properly as a system. During commissioning, it is helpful to understand the sequence of operation for each control point, which should be tested to ensure that the control system delivers desired results based on typical operating conditions. Besides operating factors, other factors such as location of controls should be considered during field commissioning. In addition, commissioning may entail programming of microprocessor-based controls. Time of day, override and event scheduling must be programmed and tested as well.

The entire construction team shall ensure that commissioning is not omitted as a cost-saving measure.

After commissioning: After commissioning, the commissioning agent should tell the Owner and the users about the intent and functionality of the controls, especially about overrides, local control capability that allows users to override a schedule or master command. In addition, the commissioning agent should turn over all documentation and instructions to the owner's maintenance personnel so they can maintain and re-tune the system as needed, implying that calibration and commissioning is an ongoing process. It is recommended that maintenance personnel inspect all lighting controls for proper operation at least once per year.

A black-out test must be completed on new systems to ensure that all emergency lights are operating in the event of a power-loss and that system calibration and settings are not affected by the temporary loss of power.

Table 2: Typical Lighting Control Commissioning and Calibration Activities	
Control Type	**Commissioning and Calibration**
Occupancy sensors and photosensors	Ensure that the sensor is correctly placed and oriented per the specifications and/or construction drawings. If unanticipated obstructions are present, it may be necessary to adjust the sensor location and orientation.
Occupancy sensors	Adjust the sensitivity and time delay of the occupancy sensor, and test to ensure it provides appropriate response. For optimal user acceptance, energy savings and lamp life, set the time delay initially for a minimum of 15 minutes (NEMA recommendation).
Daylight harvesting	All furnishings and interior finishes and materials should be installed before calibrating the sensors. Adjust the photosensor to determine the threshold for switching based on detected light level. It may be helpful to calibrate under normal daylight conditions and dusk conditions (it may be possible to close window blinds to approximate dusk). Record the calibration adjustments if possible and replicate in similar spaces.
Automatic shut-off ("sweep off")	Input the schedule into the programmable scheduling controls, incorporating weekday, weekend and holiday operating times. Ensure that overrides work and that they are located conveniently for users.
Dimming systems	It is recommended that fluorescent lamps be "seasoned" before dimming by operating them at full light output, so as to ensure uniform dimming performance across all lamps in a system. Recommendations vary, but NEMA recommends seasoning fluorescent linear lamps overnight, or about 12 hours, and compact fluorescent lamps for 100 hours, prior to dimming. Consult the lamp manufacturer to determine whether the select lamp type must be seasoned and for how long prior to dimming.
Manual dimming	Ensure correct placement of the dimmer per the construction drawings. Adjust the upper limit of the dimming range according to the task being performed, and set the lower limit of the range so that the minimum light level meets the use/application of the space.

4 IMPLEMENTATION PROCESS

4.1 General

Lighting system design is to follow the normal, professional consulting engineering process. See the University of Alberta Design and Construction Standards and Guidelines section 2.2 on the Design and Construction Process.

There are four specific stages of development and sign off at each is required by the University of Alberta. Each stage has its specific corresponding lighting design activities required. Three copies of all submissions are required for any submission to the University of Alberta during this process.

4.1.1 *Functional or Detailed Space Program*

At this initial design phase, define the Client requirements and detail the scope for the Project. For lighting, this could typically include:

- Determination of facility space standards and requirements
- Confirming acceptance of the Lighting Design Guidelines & Standards
- Identifying lighting information as required by the complexity of the project

4.1.2 *Schematic Design (30% Drawings)*

.1 Daylighting and Window Selection (See Section 4.2 follows)

.2 Lifecycle Costing (See Section 4.3 follows)

.3 Lighting Compliance Calculations (See Section 4.4 follows)

4.1.3 *Design Development (60% Drawings)*

At this stage, the lighting system submission is to include the following: Luminaire layouts for all different room functions, Power distribution block diagram, Control System block diagram illustrating all different functions and how the system will be assembled, Lighting Control Options and where/how they would be applied, Life Cycle Costing, Outside perimeter light layout with luminaire catalogue cuts, Photometric calculations for special applications.

.1 3-Dimensional Renderings (See Section 4.5 follows)

.2 Luminaire Approval (See Section 4.6 follows)

.3 Architectural Finishes (See Section 4.7 follows)

4.1.4 *Detailed Design (100% Drawings)*

At this stage the luminaire layouts are complete with branch circuit wiring and controls shown. All information must be complete and specifications coordinated for tender. Controls must include the specific performance expectations of each and every room in a schedule format that will be used for commissioning (See Section 3.1.17).

Architectural finishes are to be checked at this stage to ensure photometric results will be as designed in the 60% stage.

.1 System Mock-ups (See Section 4.8 follows)

Lighting system design is to be coordinated with architectural features, BAS controls, electrical distribution, and task illumination requirements.

Each stage of development is to address the requirements of this Lighting Design Guidelines & Standards document and confirm compliance, process.

4.2 Daylighting and Window Selection

There are opportunities to harvest daylighting in most new projects and in some renovation projects. The Schematic Design phase must address any opportunities for daylight harvesting and include a discussion about types of glazing, providing necessary data on both light transmission factors and shading coefficients for the facility glazing presented in hard copy by the Architectural Designer to the lighting designer for lighting design computations. One PDF copy of the information shall be provided for University Review and Record. The development of the architectural design should investigate the use of light shelves or special window blinds, shades, and certains to assist in maintaining ceiling level light transmission with desk level shading. Desk level shading must be considered where desks may be subjected to direct sunlight. New window technology such as photovoltaic glass elements and light directing blinds should be reviewed on a project specific basis involving both the lighting designer and architect.

4.3 Life Cycle Costing

All proposed lighting systems are to be evaluated using a full life cycle cost analysis process. The submittal shall contain an economic analysis that considers installed costs, energy use, maintenance costs, and lamp life for systems that meet lighting efficiency and lighting level requirements. Renovation and retrofit paybacks are to be calculated using only the energy savings with maintenance savings identified for information only. Submit the analysis at the schematic design phase for approval by the University of Alberta and whenever luminaire substitutions are being contemplated for cost savings or other purposes. A recommended practice for doing these calculations is documented in IES ED-150 course materials or in the IES Lighting Handbook.

If luminaire substitions are made durng the design process, (and in cost savings analysis) these calculations will need to be re-verified or redone for the suggested alternate luminaires.

4.4 Lighting Compliance Calculations

Calculations and a letter for the project file indicating building power density compliance are to be submitted by the consultant or design team staff for review by the U of A and/or its assigned agents at the Schematic Design, Design Development, and Detailed Design stage of the project by showing the intended design for typical areas of the building with the same or similar function. Designer is to submit 3 copies of the calculations to the UofA or its assigned agents for review.

The architect & lighting designers are to submit a letter signed by both parties that the architectural finishes have been coordinated for photometric performance & reduced energy consumption in the light system. This letter is to be submitted in 3 copies at the 100% design completion stage.

4.5 Three Dimensional Rendering

AGI 32 computer software is approved for the development of 3-dimensional renderings required per section 4.1.2 for the submission at the 60% Design Development Phase. Work with the architectural designer, University of Alberta project manager, and Facilities Management to confirm the views required. Typical views expected are full view of classroom, cross section of lab bench view, bench to bench lab view, typical office, typical hall & circulation area. The use of the standard library of furnishings is acceptable when developing these renderings. The review process can be done in either active video format or colour plot process. Photometric values are to be displayed in separate views using numeric values and colour shading.

4.6 Luminaire Approval

Following approval of the Schematic Design phase of the project, in the 60% Design Development Phase, the lighting consultant is to select luminaires, wherever practical/possible from a pre approved list of luminaires. Where luminaires proposed are not on the approved list the lighting consultant is to obtain a physical sample of each, complete with a photometric file, and turn over to the University for approval. All approvals will be granted in writing. Approval applications must contain luminaire information presented in the identical tabular format to that shown in Appendix D.

Once approved, these luminaires will be deemed suitable for the duration of project, and may be added to Appendix D in the future for permanent approval status. Alternate manufacturers of a similar luminaire must submit samples for approval. Future variations of already approved luminaires must also be submitted for approval before projects are tendered or product ordered. See Section 5.1 for luminaire and alternates application processes and requirements. Approximately every 3 months the list(s) of approved luminaires and alternates to pre-approved luminaires will be posted on the U of A Website.

4.7 Architectural Finishes

The colour and variety of architectural finishes play an important part in providing a comfortable environment. Generally, light colour paint finishes with high reflectance values will be required to meet the low energy density requirements. See Section 4.5 for requirements on Three dimensional renderings. These renderings require information on architectural finishes to complete accurately.

Finishes are to be coordinated

4.8 System Mock-ups

4.8.1 *Existing Building Retrofits*

Before proceeding with the development of the 100% design package, consider the full scale construction of a lighting system mock-up in areas of the building acceptable to the University of Alberta. The mock-up or mock-ups are intended to demonstrate the primary lighting systems proposed for the major areas of the building (e.g. laboratories, classrooms, offices, etc.). For lighting retrofits, measurements are to be taken before and after the mock-up at the specified task level. As mock-up areas are typically small in size, measurements must be taken and presented in a 1.5 x 1.5 meter grid.

4.8.2 *New Building Constructions*

3D Lighting Renderings will be accepted in lieu of a mock-up if other considerations such as architectural finishes, furniture, millwork and glazing do not benefit from such a mock-up. See Section 4.5 for 3D rendering requirements.

4.8.3 *All projects*

Mock-ups are to be built and revised or rebuilt and included as a project cost. The mock-ups are to be accepted by the University of Alberta as a prototype for the building only if lighting and energy performance criteria are met.

4.9 Turn Over & User Education

Efforts must be made to educate users and maintenance on any new system features for retrofits, and important features in new buildings following the completion of the construction portion of a project. Maintenance must be educated to only use specific types of lamps where required on replacements, or where group relamping schedules should be implemented. Also see Section 3.1.17 on controls commissioning and user turn over.

5 LIGHTING EQUIPMENT STANDARDS

5.1 Alternates to Specified Equipment

Alternates may be accepted at the University of Alberta's discretion and will generally not be allowed unless physical luminaire samples have been reviewed. When requested by University of Alberta, submit complete luminaire sample and photometric data prepared by independent testing laboratory for review. Photometric data to include: total input watts, candlepower summary, candela distribution zonal lumen summary, luminaire efficiency, CIE type, coefficient of utilization, lamp type and lumen rating in accordance with prescribed IESNA testing procedures.

5.2 Shop Drawings and Product Data

"Shop drawings" mean drawings, diagrams, illustrations, schedules, performance charts, photometrics, brochures and other data which are to illustrate details of a portion of the work. Shop drawings shall be submitted for all new lighting equipment being specified on a project for records and review. This includes luminaires, retrofit kits, lamps, ballasts, reflectors, sockets lenses, and any other equipment included in the specifications. Custom shop drawings shall be prepared for non catalogue items. Shop drawings shall originate from the manufacturer. Existing brochures may be submitted as shop drawings but must be clearly identified as indicated below. They shall be clearly marked with the information indicated in the project specifications, but shall include as a minimum:

- University of Alberta project name and number (Obtained from the Drawings)
- Date submitted/resubmitted
- Luminaire type/name (i.e. Type number as shown on consultant's drawings – Type 10, Type 30A, etc)
- Manufacturer and catalogue number
- Voltage
- Number of lamps / lamp types
- Finishes
- Accurate dimensions and capacities
- Accessories information including: lenses, parabolic, frames, reflectors, wire guards, ballast types must be indicated.
- All luminaire options shall be clearly selected. Unused options or generic features must be blacked or crossed out
- Signature of distributor representative and manufacturer's representative

All shop drawings must be certified correct for construction by the manufacturer and electrical contractor, as well as others identified in the project specifications before submission to the University for review and final approval.

Distributor to submit two (2) copies, one reproducible, of product shop drawings to University of Alberta for review and comment prior to commencement of manufacturing. These would be the minimum quantity of drawings required for U of A purposes – individual project specifications may impose additional requirements and copies in addition to those indicated herein. Adjustments made to and comments noted on the shop drawings are intended to assist the manufacturer with specifications' compliance and this mandatory Client compliance review shall not adversely impact the contract price. Construction documents shall allow a period of 7 working days as a minimum turaround time for University review. Shop drawing review by the Consultant, the University or its Agent(s) does not grant the distributor, manufacturer or contractor leave to proceed in error. Regardless of any information contained in the shop drawings, the requirements of the these guidelines, project drawings, specifications, and other ammending documents must be followed and are not waived or superseded in any way by the shop drawing review.

5.3 Materials Standards

The make and quality of all materials used shall be:

- Approved by the Canadian Standards Association (CSA) and/or Local Inspection Authority.
- Subject to the approval of the local authorities having jurisdiction.
- New and free from all defects.
- Standard products of the manufacturers, unless indicated otherwise.

5.4 Warranties & Guaranties

Vendor is responsible for provision of documentation confirming that manufacturer(s) warranties or guaranties meet or exceed the stipulated U of A minimums for all University facilities. State policy for replacement of defective product throughout warranty period. The following are the equipment warranty requirements:

- Linear Fluorescent lamps: minimum 20,000 hours rated life
- Ballasts: five (5) years equipment, one (1) year labour
- New luminaires and retrofit kits: one (1) year equipment
- Reflectors: All performance criteria (reflectance) to less than 5% depreciation and all construction criteria (deformation, manufacturer's defects, etc) for a minimum of ten (10) years. Labour warranty shall exist for one (1) year

- Lenses shall not crack or yellow for a minimum of ten (10) years, and be covered under Warranty.
- Exit signs/exit retrofit kits: five (5) years equipment supplied and labour replacement

All warranties shall commence from time that substantial completion is granted by the U of A for the facility or portion of the facility that has been turned over. Where partial turnovers are completed, warranties of products in that area commence from that time.

6 LUMINAIRES AND COMPONENTS

6.1 New Luminaires

All lighting products shall be certified to meet CSA standards and comply with all code regulations. For custom made fixtures, alternate approval agencies may be required per StanDATA (Visit *http://www.municipalaffairs.alberta.ca/cp_electrical_standata.cfm*).

Lensing in all new luminaries is to be captively held either through the use of lens frames, captive latching system(s) or contained inside of the luminaire body/housing by inherent features that are part of the luminaire construction.

Painted reflective surfaces inside of luminaires shall have high reflectance powder coat paint, with reflectance values at or exceeding 86% unless otherwise permitted by the University.

Luminaires utilized in damp or wet locations shall be gasketted and approved for use in wet locations.

Wherever practical, luminaires shall be designed and mounted to allow maintenance from step ladders not to exceed 8'-10' in nominal height. Where ever designers contemplate luminaire mounting height that exceeds this height a dialogue needs to be conducted with the University and approval given in writing to allow the location and mounting height being contemplated before the drawings and specifications are completed. Designers should propose group relamping schedules for areas where maintainence of single lamps at a time may be considered too labour intensive.

The catalogue numbers that follow in Section 5 are provided for reference only. Additional luminaire types that may be required shall be from same manufacturers if possible and quality listed.

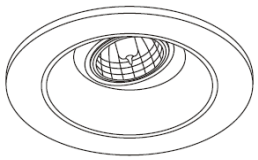
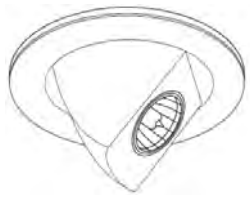
Catalogue numbers listed in Section 5 and Appendix-D are based on 120V operations. Products using 347V inputs have not been identified by this document. All catalogue numbers listed are current and have been confirmed by the manufacturer at time of the preparation of this document. All catalogue numbers should be verified with manufacturer or manufacturer's agent prior to specification development, use of the information to obtain pricing, to prepare budgets, etc. or ordering of luminaires,ballasts, lamps, accessories and other miscellaneous lighting accessories, associated fittings and equipment.

6.1.1 *Halogen Luminaires*

.1 Recessed Downlights

For use in building lighting layouts where fluorescent lighting would not satisfy design requirements. Typical applications are wallwashing, downlighting, highlighting, and spotlighting. Typical applications listed are for reference only.

Figure 1 – Recessed Pot Lights

Description: Aimable MR-16 or MR-11 recessed downlight and housing.	
Approved Manufacturer(s): RiteLight/DaSal Samples by Mfg: RiteLight/DaSal Model Type(s): Aurora #2-120, Split #2-200	

See Appendix D for list of alternate manufacturers and detailed part numbers.

.2 Track Mounted Fixtures (MR16 Track Heads)

For use in building lighting layouts where fluorescent lighting would not satisfy design requirements and track mounted lighting is desired. Applications include highlighting and spotlighting.

Figure 2 – Track Mounted Fixtures

Description: Aimable MR-16 or MR-11 track mounted lighting with up to 75W lamps.	HALO L1763 
Approved Manufacturer(s): Halo, Juno Samples by Mfg: Halo and Juno Model Type(s): Halo L1763 and Juno TL141	JUNO TL141 or TF-150/190 

Notes:

- For Fluorescent Track Lighting, see the Linear Fluorescent Luminaires
- Other manufacturers may be accepted (with approval) if they produce fixtures that can be mounted on Halo or Juno track systems.
- Model Type(s): See approved products in Appendix D for part numbers.

6.1.2 *Linear Fluorescent Luminaires*

.1 1’ x 4’ Recessed Fixtures

This is the type of luminaire that should be considered as a first choice for meeting the design criteria of most spaces while reducing energy densities. Typical applications are recessed mounting in T-Bar or drywall ceilings.

Figure 3 - 1’ x 4’ Recessed Fixtures

Description:
1 or 2 lamp T8 1’ x 4’ recessed fluorescent luminaire, 95% MIRO, or approved equal, specular reflector, steel pin hinged frame lens door, with high efficiency instant start electronic ballast. Also available in 1’ x 2’ size.

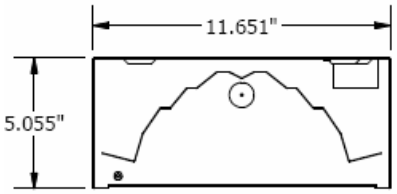
Approved Manufacturer(s):
Custom Lighting Ltd., Columbia, Lithonia, Metalux

Lens Types: K12, K19, or Holophane H24

Samples by Mfg: *Custom Lighting Ltd.*
Model Type(s): LS-402, LS-402-2, LS-402-2ft

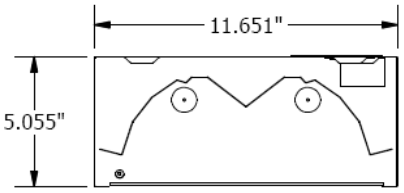
See Appendix D for list of alternate manufacturers and detailed part numbers.

1 LAMP



END VIEW

2 LAMP



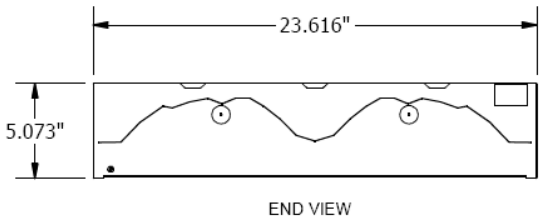
END VIEW

Note: Typically selection for recessed 1x4’ luminaries should exceed 70% efficiency level.

.2 2’ x 2’ Recessed Fixture

For use when an alternate lighting pattern is desired from the standard 1’ x 4’ fixtures. Typically T5HO should be considered for ceiling heights over 24 feet.

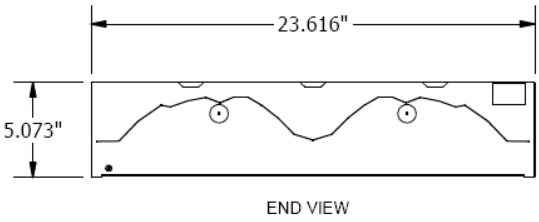
Figure 4 - 2’ x 2’ Recessed Fixture

Description: 2 lamp T8 or T5HO 2’ x 2’ recessed fluorescent luminaire, 95% MIRO specular reflector, steel pin hinged frame lens door, with high efficiency electronic ballast. Also available in 3 or 4 lamp configurations.	
Approved Manufacturer(s): Custom Lighting Ltd. Lens Types: K12, K19, or Holophane H24 Model Type(s): LS-506 See Appendix D for list of alternate manufacturers and part numbers.	

.3 2’ x 2’ Surface Fixture

For use when an alternate lighting pattern is desired from the standard 1’ x 4’ fixtures and recessed fixtures are not an option. Typically T5HO should be considered for ceiling heights over 24 feet.

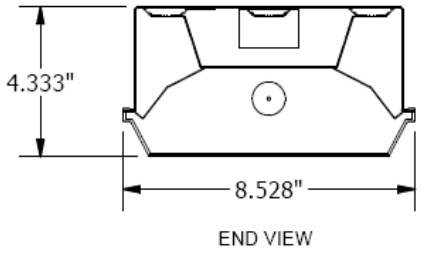
Figure 5 – 2’ x 2’ Surface Fixture

Description: 2 lamp T8 or T5HO 2’ x 2’ surface fluorescent luminaire, 95% MIRO specular reflector, steel pin hinged frame lens door, with high efficiency electronic ballast. Also available in 3 or 4 lamp versions.	
Approved Manufacturer(s): Custom Lighting Ltd. Lens Types: K12, K19, or Holophane H24 Model Type(s): LS-505 See Appendix D for list of alternate manufacturers and part numbers.	 END VIEW

.4 1’ x 4’ Wrap Fixture

For use in areas with drywall or plaster ceiling surfaces, where there is no plenum to allow installation of recessed luminaires.

Figure 6 - 1’ x 4’ Wrap Fixture

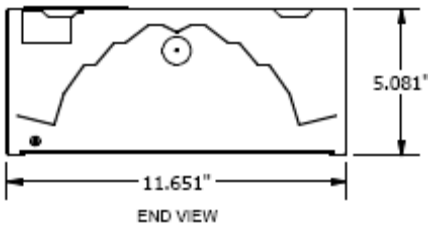
Description: 1 or 2 lamp T8 1’ x 4’ wrap fluorescent luminaire, 95% MIRO specular reflector, steel pin hinged frame lens door, with high efficiency instant start electronic ballast.	
Approved Manufacturer(s): Custom Lighting Ltd. Lens Types: K12, K19, or Holophane H24 Model Type(s): LS-101, LS-101-2 See Appendix D for list of alternate manufacturers and detailed part numbers.	1 LAMP 

Note: Narrow beam wrap version available (Custom Lighting LS-103). This should be considered for elevations greater than 15ft to 20ft.

.5 1' x 4' Surface Box Fixture

For use in areas with concrete, open truss, drywall or plaster ceiling surfaces where there is no plenum to allow installation of recessed luminaire.

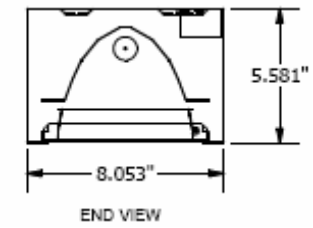
Figure 7 - 1' x 4' Surface Box Fixture

Description: 1 or 2 lamp T8 1' x 4' surface box fluorescent luminaire, 95% MIRO specular reflector, steel pin hinged frame lens door, with high efficiency instant start electronic ballast. Also available in 1' x 2' size	
Approved Manufacturer(s): Custom Lighting Ltd. Lens Types: K12, K19, or Holophane H24 Model Type(s): LS-401, LS-401-2, LS-401-2ft See Appendix D for list of alternate manufacturers and detailed part numbers.	

.6 1’ x 4’ Narrow Beam Surface Box Fixture

For use in areas with concrete, open truss, drywall or plaster ceiling surfaces where there is no plenum to allow installation of recessed luminaries. Applications include library stack and lab bench lighting.

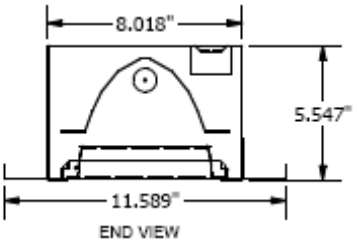
Figure 8 – 1’ x 4’ Narrow Beam Surface Box Fixture

Description: 1 lamp T8 1’ x 4’ narrow beam surface box fluorescent luminaire, 95% MIRO specular reflector, steel pin hinged frame lens door, with high efficiency instant start electronic ballast.	
Approved Manufacturer(s): Custom Lighting Ltd. Lens Types: K12, K19, or Holophane H24 Alternatively, a wide cell parabolic configuration can be used instead of lensing. Model Type(s): LS-201 See Appendix D for list of alternate manufacturers and detailed part numbers.	

.7 1’ x 4’ Narrow Beam Recessed Fixture

For use in areas with T-Bar ceiling types.

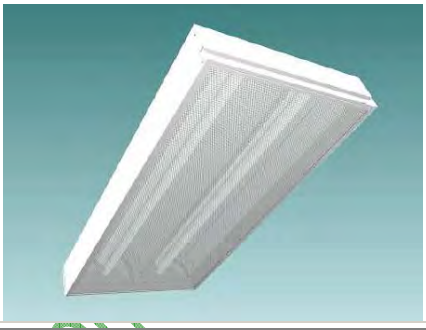
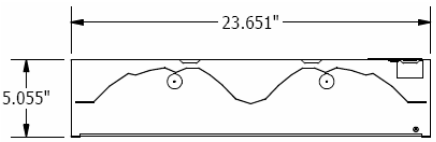
Figure 9 - 1’ x 4’ Narrow Beam Recessed Fixture

Description: 1 lamp T8 1’ x 4’ narrow beam recessed fluorescent luminaire, 95% MIRO specular reflector, steel pin hinged frame lens door, with high efficiency instant start electronic ballast.	
Approved Manufacturer(s): Custom Lighting Ltd. Lens Types: K12, K19, or Holophane H24 Model Type(s): LS-202 Specular louvers to be non-iridescent MIRO 4 specular or MIRO semispecular aluminium. See Appendix D for list of alternate manufacturers and detailed part numbers.	

.8 2’ x 4’ Recessed Fixtures

For use in areas with T-Bar ceiling types.

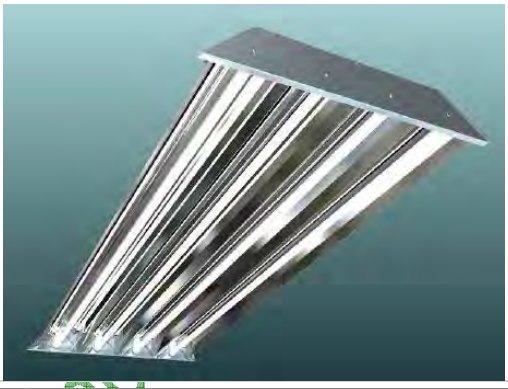
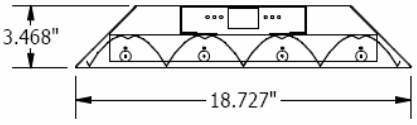
Figure 10 - 2’ x 4’ Recessed Fixture

Description: 2, 3, or 4 lamp T8 2’ x 4’ recessed fluorescent luminaire, 95% MIRO specular reflector, steel pin hinged frame lens door, with high efficiency instant start electronic ballast.	
Approved Manufacturer(s): Custom Lighting Ltd. Lens Types: K12, Clear Lexan Model Type(s): CL9R See Appendix D for list of alternate manufacturers and detailed part numbers.	 END VIEW

.9 Highbay Fixtures

For use in high ceiling areas and/or for where high lighting values are required.

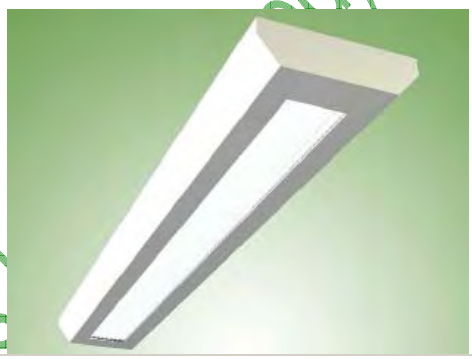
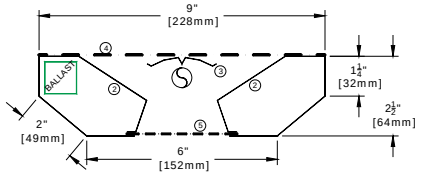
Figure 11 – Highbay Fixture

Description: 2, 3, or 4 lamp T5HO fluorescent luminaire, 95% MIRO specular reflector, steel pin hinged frame lens door, with high efficiency instant start electronic ballast.	
Approved Manufacturer(s): Custom Lighting Ltd. Lens Types: none Model Type(s): CL-HI5HO	 END VIEW

.10 Direct/Indirect Fixtures

For use in areas where both up and downlighting components are desired. Luminaires of this type and help to avoid glare and provide diffuse even lighting. Typically used in boardrooms, offices, computer rooms, and possibly high ceiling hallways. This type of luminaire should not be considered for areas containing mostly dark surfaces.

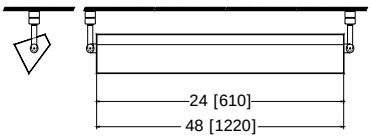
Figure 12 – Direct/Indirect Fixtures

Description: T5HO fluorescent direct/indirect fixture, specular Stucco 9 reflector, with high efficiency electronic ballast. Available in 1-lamp 4' or 2-lamp 8' lengths.	
Approved Manufacturer(s): Custom Lighting Ltd. Sample shown Mfg by: Custom Lighting See Appendix D for list of alternate manufacturers and part numbers.	

.11 Fluorescent Track Fixtures

For use in areas where track mounting fixtures is an ideal solution. Typically used in wall washing applications.

Figure 13 - Fluorescent Track Fixtures

Description: 1 or 2 lamp T5HO fluorescent track fixtures, 95% MIRO specular reflector, with high efficiency electronic ballast. Available in either 2' or 4' lengths.	
Approved Manufacturer(s): Custom Lighting Ltd. Lightolier Custom Ltg. Model Type(s): LS-1003 See Appendix D for list of alternate manufacturers and part numbers.	

6.1.3 *Compact Fluorescent Luminaires*

.1 Recessed Downlights (Vertical Orientation)

All CF Source luminaires used must be able to effectively dissipate with the heat given off by a single compact fluorescent lamp to ensure that excessive heat does not diminish the lifespan of the lamp or result in lamp socket degradation from overheating. Heat tests must be performed and documented to confirm the ballast operates minimum 20°C below the maximum design temperature. Only vertical lamp luminaires shall be accepted for new installations. Downlights with a square shaped openings are prohibited from use on University projects. Luminaire aperature diameters shall not be less than 7" for photometric efficiency and for maintenance purposes all recesses luminaires regardless of the type shall be physicall secured to the ceiling structure with metal wire, screws or straps to prevent movement during lamp change and maintenace. No luminaires shall be allowed to rest on T-Bar ceiling tiles.

Figure 14 - Recessed Downlights (Vertical Orientation)

Description: Triple tube compact fluorescent recessed downlight, vertical orientation, specular aluminium reflector with high efficiency electronic ballast. 13 or 18W Quadtube downlight versions may also be used.	
Approved Manufacturer(s): Portfolio Model Type(s): C7032/C7042 See Appendix D for list of alternate manufacturers and part numbers.	

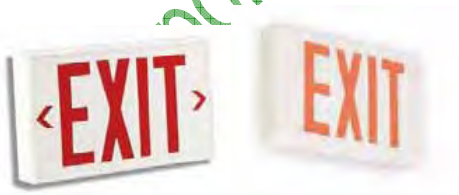
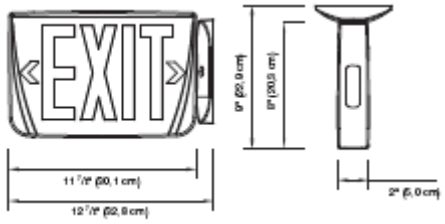
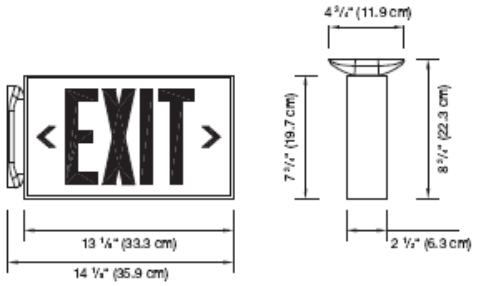
6.1.4 *Exit Sign Luminaires*

Exit Lighting luminaires should be supplied from a 120V emergency power supply. Possible options or model configurations include 1 or 2-sided, wireguarded, or top lit.

Unapproved exit lights are be approved by University of Alberta Safety Officer before use.

All exit sign luminaires should utilize LED technology. Exit signs must meet Canada Energy Efficiency Regulations. Exit Lighting luminaires must comply with CAN/CSA-C860-07 – "Performance of Internally Lighted Exit Signs".

Figure 15 – Exit Signs

Description: Exit signs can be directional, 1 or 2 sided, and constructed of either plastic or aluminium. Available for wall, end or ceiling mounting.	
Approved Manufacturer(s): Lumacell, Emergi Lite. Samples shown by Lumacell. Approved Model Type(s): Grande Series (Plastic) LER400 Series (Aluminium) LER2000 Series .	 Grande Series  LER400 Series

6.1.5 *HID Lighting Fixtures*

The use of HID Lighting Fixtures is restricted.

When the use of HID Luminaires is contemplated, a written variance for approval must be submitted and acceptance of HID for each type and location must be received prior to the luminaire type is entered into the design drawings and specifications. HID Luminaire shop drawings shall be submitted to the University for review. Shop drawings for HID fixtures must include Noise Criteria. Shop drawings shall indicate a noise criteria of ≤ 30 dB for HID luminaires otherwise the fixture will be rejected.

In instances where HID is accepted as the sole source of lighting in any space the cold start halogen lamp option shall be selected for luminaires to provide low level illumination until the HID lamps are able to restrike and return to full brilliance.

Where used, the fastening systems for HID luminaires weighing more than 15 lbs shall be approved by a structural engineer. This is especially necessary in the case of high bay lighting suspended by a stem, chain or hook.

If supplemental safety chains or cables are required for each luminaire, the proposed solution for emergency support shall also be approved by a structural consultant.

New HID luminaires shall use lamps with medium bases. Lamps must be used for their intended application (i.e. vertical or horizontal as specified)

6.2 Housings (Linear Fluorescent Luminaries Only)

Housings shall consist of a minimum 22 gauge.

There shall be no sharp edges that may injure someone during the installation, maintenance, or removal of fixtures.

Housings shall use screw or rivet fasteners, tab style or slip fit fasteners are not acceptable.

Lens frames to be pin hinge type and welded in place and allowed to swing freely in holes punched in the ends of the luminaire housing.

6.3 Linear Fluorescent Ballasts

Instant start ballasts are approved for most applications, in particular for master-slaving circuiting. Master-Slaving (Tandem wiring) is approved to save ballast quantities and reduce maintenance costs. However this type of wiring is not to be used for 25W low-watt T8 lamps. Tandem wired luminaires shall be marked with permanent identifying labels to differentiate between luminaires with ballast and those without. Labels shall be located on luminaire frame or on adjacent ceiling trim or tee-bar. Label to reflect ballast location, type of ballast used (i.e. EM), size and location visible from floor, white background with black lettering.

There must be at least two ballasts per room, if there are two or more fixtures in a room to avoid having a single point of failure for all the room's lighting.

Only single lamp ballasts shall be used for single lamps. Two lamp ballasts are not to be used for single lamps.

Rapid start ballasts are approved for specific applications such as locations where average on time is less than 3 hours per start and programmed start ballasts are approved for similar use for areas of high switching frequency in University Facilities.

Magnetic core & coil ballasts are used on campus but are prohibited from use except for maintenance purposes, HID luminaires and by written variance for other uses because of advances in technology and the availablity of more energy efficient products.

University of Alberta power available in facilities for illumination systems is 120V and/or 347V*, and all 347V* ballasts must have disconnects in the line/supply side wiring to meet electrical code requirements. See products section for data on disconnects.

DALI ballasts are not approved at this time.

(**Note:** 347* Volt lighting design and installation is permitted only in existing facilities where the switch to 120V lighting is not practical and for maintainer safety vis-à-vis consistent application in the facility).

6.3.1 *T8 Electronic Ballasts (Up to Four Lamps)*

- Rating: 120V or 347V*, 60Hz, for use with specified lamps.
- Standards certification: CSA (and acceptable alternate certification agencies)
- Transient protection meets ANSI spec C62.41: Pass lab test.
- EMI/RFI emissions meet FCC CFR 47 Part 18, Sub-part C Class A: Pass FCC certified lab test, Class A
- Sound level rating: Class A
- Minimum starting temperature: 10ºC.
- Designed for operating ambient temperature: 40ºC.
- Total Harmonic distortion (THD) of line current shall not exceed 10% of basic phase current for primary lamp applications.
- Minimum power factor: .95 or greater
- Minimum ballast factor: .85 or greater
- Lamp current crest factor (ANSI Spec test): < 1.7.
- Instant start ballasts must meet ANSI C82.1
- Maximum starting interval: <50ms.
- Lamp operating frequency: 42 - 60 kHz.
- Operation in failed lamp mode: Ballast shuts off **or** operates remaining lamp at <32% THD, .85 PF or greater.
- Capacitor: non-PCB, thermally protected.
- Thermal protection: auto resetting.
- Mounting: Integral to the luminaire.
- Ballast shall contain protected circuitry to ensure that ballast is not damaged when lamps are removed with power on.
- For each project common lamp type, ballasts connected to the same voltage level shall be of one manufacturer, (e.g. all 120V, F32T8 lamp measures specified shall have ballasts of one manufacturer).

Table 3: T8 Electronic Ballast Power Consumption		
Lamp Type	**No. Lamps**	**Max. Ballast Watts With Lamps**
F32T8	**1**	**32**
F32T8	**2**	**60**
F32T8	**3**	**90**
F32T8	**4**	**116**
F25T8	**1**	**28**
F25T8	**2**	**48**
F17T8	**1**	**25**
F17T8	**2**	**38**
F17T8	**3**	**56**
F17T8	**4**	**68**

.1 T8 Electronic Ballasts - Acceptable Manufacturers:

- PHILIPS\Advance
- OSRAM/SYLVANIA
- GE

6.3.2 *Energy Saving Ballasts - T8 Electronic (two, three and four lamp)*

- Rating: 120V, 60Hz, for use with specified lamps.
- Standards certification: CSA.
- Transient protection meets ANSI spec C62.41: Pass lab test:
- EMI/RFI emissions meets FCC CFR 47 Part 18, Sub-Part C Class A: Pass FCC certified lab test, class A.
- Sound level rating: Class A.
- Minimum starting temperature: 10ºC
- Designed for operating ambient temperature: 40ºC
- THD of less than 20%
- Minimum power factor: .95+
- Minimum ballast factor, unrecoverable light loss: .75+.

- Lamp current crest factor (ANSI Spec test): <1.7.
- Instant start qualification: meets ANSI C82.1.
- Maximum start interval: <50ms.
- Lamp operating frequency: 42 - 60 kHz.
- Operation in failed lamp mode: Ballast shuts off or operates remaining lamp at <32% THD.
- Capacitor: non-PCB, thermally protected.
- Thermal protection: auto resetting.
- Mounting: integral with luminaire.
- Ballast shall contain protected circuitry to ensure that ballast is not damaged when lamps are removed with power on.

Maximum total ballast Watts with lamps:

Table 4: T8 Energy Saving Electronic Ballast Power Consumption

Lamp Type	No. Lamps	Max. Ballast Watts With Lamps
F32T8	**2**	**53**
F32T8	**3**	**78**
F32T8	**4**	**100**

.1 T8 Energy Saving Electronic Ballasts - Acceptable manufacturers:

- PHILIPS \ Advance
- OSRAM \ SYLVANIA
- GE

6.3.3 *Overdrive Ballasts – T8 (two, three and four lamp)*

These ballasts are prohibited from use, except in special circumstances and with written approval in the form of a variance from the University. Overdriving lamps tends to reduce lamp life and as such, other options are to be explored to increase light levels before considering implementing the use of overdrive ballasts.

- Rating: 120V, 60Hz, for use with specified lamps.
- Standards certification: CSA.
- Transient protection meets ANSI spec C62.41: Pass lab test:
- EMI/RFI emissions meets FCC CFR 47 Part 18, Sub-Part C Class A: Pass FCC certified lab test, class A.
- Sound level rating: Class A.

- Minimum starting temperature: 10ºC
- Designed for operating ambient temperature: 40ºC
- THD of less than 20%
- Minimum power factor: .95
- Ballast factor: 1.1 – 1.2
- Lamp current crest factor (ANSI Spec test): <1.7.
- Instant start qualification: meets ANSI C82.1.
- Maximum start interval: <50ms.
- Lamp operating frequency: 42 - 60 kHz.
- Operation in failed lamp mode: Ballast shuts off or operates remaining lamp at <32% THD.
- Capacitor: non-PCB, thermally protected.
- Thermal protection: auto resetting.
- Mounting: integral with luminaire.
- Ballast shall contain protected circuitry to ensure that ballast is not damaged when lamps are removed with power on.

Maximum total ballast Watts with lamps:

Table 5: T8 Overdrive Electronic Ballast Power Consumption

Lamp Type	No. Lamps	Max. Ballast Watts With Lamps
F32T8	**2**	**74**
F32T8	**3**	**111**
F32T8	**4**	**146**

.1 T8 Energy Saving Electronic Ballasts - Acceptable manufacturers:

- PHILIPS \ Advance
- OSRAM \ SYLVANIA
- GE

6.3.4 *T5HO Electronic Ballasts (up to 4 lamps)*

- Shall be programmed start
- Shall contain auto restart circuitry in order to restart lamps without restarting power
- Shall operate from 60Hz input source of 120V or 347V* (See section 2.6 for restrictions on 347V* use) with sustained variations of +/-10% (voltage and frequency) with no damage to the ballast

- High frequency electronic type and operate lamps at a frequency above 42kHz
- Power Factor greater than 0.98 for primary lamp
- Minimum ballast factor of 1.00 for primary lamp application
- THD of less than 20%
- Class A sound rating
- Shall provide Lamp EOL Protection Circuit
- Ballast shall have a hi-low switching option when operating (4) F54T5/HO lamps to allow switching from 4-2 lamps, 3-2 lamps or 3-1 lamp.
- Provided with integral leads or poke-in wire trap connectors colour-coded per ANSI C82.11
- Shall not contain any PCBs
- Shall be ULC listed, CSA certified

.1 *T5HO Ballasts* - Acceptable manufacturers

- PHILIPS\Advance
- OSRAM/SYLVANIA
- GE

6.4 Compact Fluorescent Ballasts

- Universal compact fluorescent ballasts designed to operate a range of ballasts are not approved for use.
- Rating: 120V, 60Hz, for use with compact fluorescent lamp as specified, wattage as indicated for each specified luminaire type. (See Section 2.6 for conditions on the use of 347V* for a lighting systems supply voltage.)
- Power factor: minimum .95
- Lamp crest factor shall not exceed 1.7 for the ballast.
- Total harmonic distortion (THD) of line current shall not exceed 10% of basic phase current for primary lamp applications.
- Minimum starting temperature 10ºC.
- Mounting: Integral with luminaire.
- All compact fluorescent luminaires specified shall be furnished with compact fluorescent ballasts as specified herein, unless specified otherwise
- Ballasts shall have End of Life detection (E.O.L.) for lamps and shutdown circuit.

.1 Acceptable Compact Fluorescent Ballast Manufacturers:

- PHILIPS \ Advance
- Standard
- OSRAM/SYLVANIA

6.5 Metal Halide Ballasts

- Shall operate from a nominal line voltage of 120 volts, +/-10%, 60Hz
- Total Harmonic Distortion (THD) of less than 15%
- Power Factor greater than 90%
- Lamp crest factor less than 1.4
- Shall have a lamp end-of-life detection and shutdown circuit
- Sound Rated A
- Output frequency shall be less than 200 Hz to prevent acoustic resonance inside the lamp arc tube and to minimize visible flicker
- Shall be thermally protected to shut off when operating temperatures reach unacceptable levels
- Furnished with integral, color-coded leads
- Shall not contain PCBs
- Shall be UL and CUL 'listed or recognized'
- All metal halide luminaires specified shall be furnished with the ballasts as specified above, unless specified otherwise.

.1 Acceptable Metal Halide Ballast manufacturers:

- PHILIPS \ Advance
- Standard
- OSRAM/SYLVANIA

6.6 Lamps

6.6.1 *Linear Fluorescent Lamps*

The typical linear fluorescent lamps to be used for the greater part of the University illumination applications should be a nominal 48" in length, 32 watt, T8, bi-pin. Lower wattage 4 foot 25W T8 lamps are also approved for use in University facilities. T5HO lamps should be considered for high ceiling or higher illumination requirements. Shorter lamps should be avoided, but can be considered in locations lacking the space needed for a 4' luminaire.

All fluorescent lamps are to be Low Mercury type. Low Mercury fluorescent lamps are defined as those that meet or contain below the acceptable stipulated levels as outlined in the US EPA (Environmental Protection Agency) standards for Toxic Characteristics Leaching Procedure (TCLP).

In the future, governmental regulations will require that only mercury in an amalgam form will be allowed to be used in lamps. Amalgam is mercury blended with another metal or alloy such that it will be non-soluble and therefore have less impact on the environment.

Linear fluorescent lamps shall carry a one year manufacturer's standard warranty and two year warranty when operated on ballast of same manufacture.

The University standard for lamp color temperature in new installations and renovations shall be the 4100 series lamps. Except where designers can demonstrate a need to use 3500 lamps to bring out the richness in wood surfaces, to prevent contrast in existing installations or for special effect. Where 3500 lamps are for other purposes noted above a variance application must be made in writing stating the rationale for 3500 lamp use. If the application is accepted then release is given to employ the 3500 lamps for a project/project area.

Table 6: Linear Fluorescent Lamps

Type of Lamp (Nominal length used)	Wattage	Colour Temperatures	Initial Lumens	Minimum Colour Rendering Index	Rated Lifetime (hours)
4 Foot T8	32	3500, 4100	2950	80	30000
4 Foot Low Watt T8	25	3500, 4100	2500	80	30000
3 Foot T8	25	3500, 4100	2200	80	20000
2 Foot T8	17	3500, 4100	1375	80	20000
4 Foot T5HO	54	3500, 4100	5000	80	25000
2 Foot T5HO	24	3500, 4100	2000	80	25000

.1 Acceptable Linear Fluorescent Lamp manufacturers:

- GE
- OSRAM/SYLVANIA
- PHILIPS

6.6.2 *Compact Fluorescent Lamps*

All fluorescent lamps are to be Low Mercury type. Low Mercury fluorescent lamps are defined as those that meet or contain below the acceptable stipulated levels as outlined in the US EPA (Environmental Protection Agency) standards for Toxic Characteristics Leaching Procedure (TCLP).

In the future, governmental regulations will require that only mercury in an amalgam form will be allowed to be used in lamps. Amalgam is mercury blended with another metal or alloy such that it will be non-soluble and therefore have less impact on the environment.

Compact Fluorescent lamps shall carry a one year manufacturer's warranty.

Both dimmable and non-dimmable lamps may be used.

Plug-in style (cartridge) compact fluorescent lamps shall be 4 pin, with a built-in starter and radio frequency interference (RFI) capacitor.

Screw-in style compact fluorescent lamps shall be of medium screw base construction and shall have an integrated electronic ballast. Plug-in style lamps shall utilize ballasts designed specifically to operate that particular lamp.

Table 7: Compact Fluorescent Lamps

Type of Lamp	Approved Wattages	Minimum Colour Rendering Index	Rated Lifetime (hours)
Twister/Open	5, 13, 20, 23	80	8000-10000
Candelabra	5, 9	80	6000-8000
R20, R30, PAR38	14, 15, 23	80	8000
Plug-In (Twin)	7, 13	80	10000
Plug-In (Quad)	13, 18	80	10000
Plug-In (Triple Tube)	32, 42	80	10000
PL-H	85, 120	80	20000

.1 Acceptable Compact Fluorescent Lamp manufacturers:

- GE
- OSRAM/SYLVANIA
- PHILIPS
- PANASONIC
- STANDARD

6.6.3 *Halogen Lamps*

Halogen lamps utilized must have rated lifetime of at least 10,000 hours.

Acceptable beam angle spread is 12° to 60°, wattages from 20-50W are preferred. Use of wattages greater than 50W for halogen lamps requires UofA approval of a variance form submitted by the lighting designer.

Note that the use of 35 watt lamps on 50 watt power supplies typically extends the life of the power supply by 100%.

.1 Acceptable Halogen Lamp manufacturers:

- GE
- OSRAM/SYLVANIA
- PHILIPS
- USHIO
- IWASAKI

6.7 Sockets

Sockets should be constructed using PBT (a thermoplastic material) or a polycarbonate material. Socket shall use a highly effective lamp pin support that reliably prevents base pin deflection even on older lamps and that guarantees a durable and firm contact.

Twist and lock shunted sockets should be used for all standard T8 and T5HO technology.

MR Series sockets to be ceramic and minimum temperature rating to match the luminaire being used.

Metal Halide sockets to be ceramic 5kV pulse start rated.

No specialty lamp holders are allowed. If the University approves non-standard sockets, then a quantity of the sockets used must be provided to maintenance in order to sustain luminaire operation.

.1 Acceptable manufacturers:

- VOSSLOH-SCHWABE
- LEVITON

6.8 Reflectors

6.8.1 Reflector Construction

- Manufactured of aluminium, minimum thickness of .020".
- Approved reflective materials are anodized aluminium or polished stainless steel to achieve performance criteria. Coated reflector material is not approved.
- Reflector shall be constructed to enable rigid installation into luminaire via screws.
- Luminaire retrofits with reflectors shall have quality control checks done to ensure that screws have not be stripped using power tools, making it difficult to access ballast compartments later on.
- Installed reflector shall not interfere in any way with opening of luminaire, removal of lens/louvre, or relamping. Reflector itself shall be easily removed from the luminaire.
- Provide socket plates and new shunted sockets with reflectors designed to position sockets and lamps for optimum luminaire performance for T8 technology.

6.8.2 Reflector Performance and Warranty

Except for powder coated white industrial luminaire reflectors, reflectors shall have a minimum total reflectance of 95%. Reflectors shall be corrosion, fire and chemical resistant. Surface shall not yellow, peel, blister, crack, or delaminate, and shall be low iridescence. Reflectors shall be non-static, and protected by manufacturer using coating or layer type of protection from damage due to ultra-violet radiation. Reflectors should follow a design pattern engineered to produce the intended illumination distribution.

Reflectors shall come with a 25 year manufacturer's warranty.

.1 Acceptable Manufacturers:

Horizon

Anomet (MIRO)

6.9 Lenses

Lenses shall be meet the following guidelines:

- clear prismatic acrylic type, size to suit luminaire, installed c/w clips.
- 0.125" thick, c/w maximum prism depth of .080".
- Acrylic shall be 100% high molecular weight virgin material meeting grade 8 requirements as set forth in Table 2 of ASTM D-788-69a.
- Lenses shall not crack or yellow for a minimum of ten (10) years, and be covered under manufacturer warranty.

There are a variety of different lens types which are acceptable for use. Lensing should be selected based on the desired lighting characteristics including light spread, glare control, and transmission.

If glass lensing is to be utilized, glass shall be crystal clear, free of imperfections that may interfere with the optical performance. Transmittance of glass materials shall not be less than 70% if used as part of luminaire.

White Opal acrylic is prohibited from use without a variance application being approved because of its poor light transmission value.

6.9.1 *Acceptable manufacturers:*

American Louvre of Canada

KSH Canada Inc.

Sabic Polymershapes

6.10 Luminaire Disconnect

All new luminaries with designated voltage ballasts above 150 volts or with multi-voltage ballasts where at least one of the voltages exceeds 150 volts shall be complete with a CSA approved disconnect as per CEC 2006 Section 30-308-4.

For luminaire retrofits or for ballast changes involving designated voltage ballasts supply voltages above 150 volts or with multi-voltage ballasts where at least one of the supply or tap voltages exceeds 150 volts a purpose specific disconnect shall be provided to isolate the ballast from the supply without needing to unsplice the incoming supply to the ballast.

6.10.1 *Acceptable luminaire disconnect manufacturers:*

WAGO

Ideal

6.11 Cover Plates

6.11.1 *Underside Cover Plates for Luminaires – Construction*

Cover plates shall be manufactured of 22 gauge steel minimum to act as ballast cover.

Surface finish of plates shall match existing luminaires. Stable polymer paints should be used to ensure minimum aging degradation.

Retrofit Cover Plates shall be constructed to enable rigid fastening to luminaire via machine screws, or existing frames.

Plates must have fixing holes. Screw heads to be installed flat with underside or side of luminaire or as unobtrusively as possible, i.e. no extruding rounded heads.

Screws should match luminaire colour closely.

Manufacturer to measure luminaires before producing plates and to provide sample for final approval before full scale production.

.1 Acceptable manufacturers:

JAFtech Manufacturing

Custom Lighting

6.12 Luminaire Retrofits

6.12.1 *General*

When existing luminaries are to be modified in any way, all work must be done in accordance with local codes and jurisdiction. This includes the addition of a dedicated ground wire for luminaries if they had been installed before this became a code requirement.

All modified luminaires must have labelling applied, identifying the new electrical characteristics including: recertification labelling, from an approved testing agency per regulations. New labelling must be typed, clearly visible and detail all electrical modifications to the luminaire including, but not limited to, lamp type, ballast type, voltage, amperage, and ballast factor.

All conversion/retrofit kits utilized in retrofits of luminaries shall be comprised of properly certified components and have valid and current certification from an approved testing agency. When a single luminaire of a given type is approved, the remainder of that type are approved.

See the appropriate sections for approved products such as disconnects, reflectors, sockets, and lenses.

6.12.2 *Fluorescent Retrofits*

When a retrofit includes for a reduction in lamp quantities, lampholder positions must be relocated and aligned to produce even illumination over lens surface. Provide replacement socket brackets for the modified luminaires. The new socket mounting brackets are to be coordinated with reflectors to ensure all wiring and connectors are covered.

All retrofit of fluorescent luminaires where voltages exceed 150 volts shall include a disconnect for live make and break, as required, under CEC 2006. Install per manufacturer's instructions, or code requirements if greater.

Turret socket lampholders in industrial style luminaires should be replaced if the lampholder or end cap are damaged or if spring in plunger socket is broken or is not functioning correctly.

T8 Technology retrofits for older luminaires shall have new shunted sockets installed for T8 lamps.

Replacement lenses shall match existing wherever possible and need not be on the approved lens type list. See products section on lenses for approved lenses to use for new luminaires.

6.12.3 *Downlight and Incandescent Luminaire Conversions*

Reflectors shall be of sufficient depth and design so that the direct view of the lamp is not possible from greater than 30° as measured from the vertical plane. Lamp image in the reflector shall be a minimum of 20° as measured from the vertical plane.

Converted luminaire shall be a minimum of 65% efficient and 80% of the light output is to be within 30° as measured from the vertical plane.

Documented ballast temperature in operation must show max ballast temperature to be 20°C below the maximum ballast rating under full operation.

6.13 Raceways & Wiring

- All wiring running in excess of 3m must be installed in a raceway
- Use only metal raceways for branch circuit & control wiring
- Metal tray may be used for LV wiring
- Runs longer than 3m are to be metal tubing (EMT) or galvanized rigid conduit
- Shorter runs less than 3m may be BX type cable
- #14 AWG copper wire will be accepted for luminaire drops only

7 LIGHTING CONTROLS

The following is a list of approved lighting controls manufacturers and products.

7.1 Manual Controls

7.1.1 *Line Voltage Switches (120V)*

.1 Specifications:

- Standard wall switch ON/OFF operation
- Toggle or Decorator Style
- Hospital Grade
- Install in generously sized outlet boxes, minimum 4x4x2.5’ depth.
- Corrosion resistant switches in damp areas

.2 Approved Manufacturer(s):

Hubbell, Lutron, Philips, Leviton, Sensor Switch, and any other reputable manufacturers who meet the specifications.

7.1.2 *Line Voltage Switches (347V)*

.1 Specifications:

- Standard wall switch ON/OFF operation
- Toggle or Decorator Style
- Hospital Grade
- Install in generously sized outlet boxes, minimum 4x4x2.5’ depth.
- Corrosion resistant switches in damp areas

These are to be used in retrofit applications only. New installations shall utilize 120V line voltage.

2. Approved Manufacturer(s):

Hubbell, Lutron, Philips, Leviton, Sensor Switch, and any other reputable manufacturers who meet the specifications.

7.1.3 *Local Dimmers (Slide & Rotary)*

Local Dimmers allow local dimming and on/off control of one zone of lighting. Control can be raised/lowered for sliders or rotated for rotary styles to select light level and can also be used to turn light on/off. These should be used in one room applications and ganged to a maximum of 5 dimmers. Beyond 5 dimmers the design should consider a scene control type of local dimming system.

Dimmer models selected must be coordinated to the type of load being controlled. Possible source types include incandescent lighting, magnetic low voltage lighting, electronic low voltage lighting, and fluorescent lighting. Any low voltage dimmers used are to be compatible with the transformer type being used in the low voltage product.

Lighting designers must ensure that any requirements on heat sink sizing, space between dimmers, and circuit loading maximums are satisfied.

.1 Specifications:

- Minimum 1000watt rated
- Specification Grade
- Install in generously sized outlet boxes

.2 Approved Manufacturer(s):

Hubbell, Lutron, Philips, Leviton, Sensor Switch

7.2 Automatic Controls

7.2.1 *Passive Infrared Motion Sensors*

These are best for use in areas with an unobstructed view, high air flow, or for the control of ceiling fans.

Specifications: Must be a “smart” sensor with self-learning or adaptive technology.

Approved Manufacturer(s): Lutron, Douglas Controls, Sensor Switch, Watt Stopper, Hubbell.

Manufacturer	**Model Numbers**
Lutron	LOS-CIR-1500-WH
Douglas Controls	WRM-5104
Sensor Switch	CM-9
Watt Stopper	CI-300
Hubbell	PIR-10

Similar alternate models by these manufacturers will also be accepted (ie - both wall or ceiling mount models are acceptable depending on the application)

7.2.2 *Ultrasonic Motion Sensors*

The use of these sensors is restricted.

7.2.3 *Dual Technology Sensors*

The 2 possibilities at present for Dual Technology Sensors include either PIR/Microphonic sensors **or** PIR/Ultrasonic sensors. Only the passive type (PIR/Microphonic) sensors should be used in order to avoid transmitted ultrasonic high frequency energy that may interfere with human comfort and health and with some equipment function (i.e.: smart board systems).

These are generally the best choice for occupancy sensors except for locations where sound will carry long distances such as parkades. In those areas/applications, the single technology PIR only sensors should be used.

.1 Specifications:

Must be a "smart" sensor with self-learning or adaptive technology.

.2 Approved Manufacturer(s):

Douglas Controls, Sensor Switch, Hubbell

Manufacturer	**Model Number**
Douglas Controls	CM-PDT
Sensor Switch	CM-PDT
Hubbell	OMNIDIA

Similar alternate models by these manufacturers will also be accepted (both wall and ceiling mount models are acceptable depending on the application for example).

7.2.4 *Photocell Sensor*

Approved Manufacturer(s): Lutron, Douglas Controls, Sensor Switch, Watt Stopper, Hubbell

Manufacturer	**Model Number**
Lutron	MW-PS
Douglas Controls	WPS-5527
Sensor Switch	CM-PC or CMR-PC
Watt Stopper	EW-200
Hubbell	LUXSTATSO

Similar alternate models by these manufacturers will also be accepted.

7.3 Low Voltage Control Devices

The following devices do not include such components as timers, relay group controllers, etc. These are considered to be part of the Integrated Lighting Control requirement.

7.3.1 *Low Voltage Switches*

Any products used in this category must be part of the manufacturer's standard product list. For example, if a Douglas Controls system is being used, switches used should also be Douglas controls.

.1 Specifications:

- 2 or 3-wire switches utilize internal diodes to provide an ON or OFF pulse
- All switches in a station can connect to the same 24VAC power common and switches can connect to multiple relays, minimizing wiring
- White terminal of a switch connects to 24VAC source, red terminal connects to relay(s)
- LED indicator switches (green = OFF, red = ON) require no additional wiring
- LED indicator switches include a space inside the cap for a switch label.

.2 Approved Douglas Controls (2-Wire) switches include:

- WR-8001 (rocker switch)
- WR-8121 (toggle switch)
- WR-8321 (vandal proof switch)
- WR-8501 (LED switch)
- WR-8503 (3-LED switch module)

.3 Approved GE (3-Wire) switches include:

- RS2-xxx, RP2-xxx, RMP2-35 (push button types)
- GE5935-xG, xx07x (toggle types)

Other manufacturers standard LV switches will be acceptable if their control system is selected for use.

7.3.2 *Low Voltage Control Relays*

.1 Specifications:

- Latching relays rated for 20A branch circuits
- Screw terminals on line/load side and coloured pre-stripped leads on control side
- Built-in override lever & ON/OFF indicator
- Fits to standard 1/2" pipe knockout (7/8" hole)
- SCCR Rating minimum 5KA

.2 Approved Manufacturer(s):

Manufacturer	**Model Numbers**
Douglas Controls	WR-6221, WR-6161, WR-6172
GE	RR7P, RR9P

7.4 Integrated Lighting Controls

In buildings where a system currently exists, upgrades should use the same manufacturer unless it is cost prohibitive. Any vendor that is selected must have local representation that is available to assist with any issues that arise with their product.

The light control system must use standard on/off or dimming ballasts with separate interface devices (i.e. – ballasts with integrated data functionality should be avoided).

Major system components shall be installed in electrical rooms or cabinets (not ceiling spaces) when feasible. Any necessary data conductors or proprietary cabling is to be run in cable tray in the ceiling space with maximum 2 meter drops or spans to devices. Consultants must show these devices and cable tray on their drawings.

Many lighting control manufacturers offer “gateway” devices that will allow dissimilar networks to interoperate (for example, a Hubbell LonWorks lighting control system interfacing with a BACnet HVAC control system). These gateways often sacrifice some functionality that would be available to a homogeneous system. Additionally, the gateway may need to be updated when either network is altered or upgraded. For these reasons, homogeneous networks are preferable to gateway-connected dissimilar networks.

All components shall be complete with approvals pertaining to the component’s operation and function (CSA, CUL, etc).

Read related control sections in Section 3 for additional information and requirements on control systems.

.1 Approved Manufacturer(s):

- Hubbell Building Automation LX System (LonWorks)
- Douglas Lighting Controls (LonWorks)
- SensorSwitch nLight Series (Proprietary)
- Encelium (Proprietary)
- Gentec (LonWorks)

8 DRAWING STANDARDS

Design drawings are to adhere to the University of Alberta Department of Planning and Infrastructure CAD procedures manual current edition:

http://www.uofaweb.ualberta.ca/pi/pdfs/ConsultantDesignDrawingStandards.pdf

Design groups should use the Electrical symbols shown in **Appendix B**.

Prior to issuing drawings for the mandatory safety codes review, the Project Manager must be advised of the number of drawings in the set and drawing titles. The Project Manager will provide drawing numbers conforming to the University drawing numbering system.

All AutoCAD "Record" drawings submitted for deposit into the UIRAP records library must be formatted to conform to the following standards:

- U of A Title Block D size (24x36) E size (36x48) must be used & limits set to that size in Layout Space. Ensure that you have the most current U of A Title Block which can be found at the link below:

  http://www.uofaweb.ualberta.ca/pi/nav02.cfm?nav02=22361&nav01=22121

- Drawings must be saved in Paper Space and Page Setup must match example shown in Appendix C
- Raster images in drawings must be inserted as embedded or linked OLE objects and not as a referenced image. Examples include logos and digital photos.
- External references must be bound using the insert option in the Xfer Manager.
- All drawings submitted have to be a separate drawing file. If you're using more than one layout space each one must be submitted as a separate drawing.

Failure to comply with these standards will result in all drawings being rejected and resubmission (post correction) will be required.

Also see Appendices C1, C2, C3 for drawing related requirements and for Title Block Standards and Layer Assignment Tables.

APPENDIX A - LIGHTING PERFORMANCE VALUES

Average horizontal illumination values are to meet the following values within a given space. Initial design and post-construction measured values (new or retrofit) are to be 10% higher than listed below to allow for the overall lighting depreciation factor. Values are to be measured at task level such as desk level in offices or floor level along corridors, pathways, washrooms, in gymnasiums, office circulation spaces, toilet stalls, etc.

Appendix A Table: - Lighting Performance Values

Type of Space	**Illumination Value (LUX)**
Office Work Space(s)	450
Office Circulation Space(s)	300
Conference Rooms	500
Classroom Desk Level	400
Computer Classrooms / Labs	350
Laboratory Work Surface(s)	700
Hallways, Corridors and walking paths through mechanical rooms	150
Hallways and Corridor Intersections and Major Interior Door Entrances	250
Stairwells Tread Level	200
Washroom Circulation Areas at Floor Level	250
Washrooms Inside Stalls (3ft height)	100
Visual Aid Boards (Vertically Mounted)	250
Libraries Desk Level	500
Libraries Bookstacks - Bottom Row (Vertical)	100
Gymnasiums at Floor Level	500-700
Mechanical Rooms at Task Level (3ft height)	400
Parkades at Floor Level	50
Lounge/Cafeteria Seating at Table Level	150
Lounge/Cafeteria Eating – Table Top	300
Lounge/Cafeteria Serving Area – Counter Height	500
Lounge/Cafeteria Food Prep – Counter Height	500

Glossary of Terms

Ballast

A device used with a gas discharge lamp to provide the necessary starting and operating electrical conditions.

Candela (cd)

The fundamental unit from which all other lighting units are derived. Candlepower, the intensity of light in a specified direction, is measured in candelas. An ordinary wax candle has a candlepower of about on candela.

Candelas are used to compare intensities of different kinds of directional light sources. In a 75 W spotlight lamp the centre of beam is 1,730 candelas and in a 75 W floodlight lamp it is 430 candelas, i.e., the centre of the spotlight's beam is four times as intense as the floodlight's.

Diffuser

A device commonly put on the bottom and/or sides of a luminaire to redirect or scatter the light from a source.

Diffusion

The scattering of light that falls on a surface.

Efficacy

The ratio of total lumens produced by the light source to the watts consumed by the source, expressed in lumens per watt.

Efficiency

The ratio of the total lumens emitted by the luminaire to those emitted by the lamp, expressed as a percentage.

Electromagnetic Spectrum

The total range of wavelengths of frequencies of electro magnetic radiation. The visible portion covers a wavelength from approximately 380 mm to 780 mm (1 mn = 10^{-9} m).

Foot Candle (fc)

The practical working unit for the measurement of lighting level equal to one lumen falling uniformly on an area of one square foot.

Illuminance

Luminous flux density or lumens per unit area incident on a surface. The unit of illuminance is the LUX (lx) where

1 lx = 1 lm/m2 (SI units) or the foot candle (fc) where

1 fc = 1 lm/ft2 (Imperial units). The relationship between LUX and foot candle is 1 fc = 10.76 lx.

Illuminating Engineering Society of North America (IESNA)

The recognized technical authority in the illumination field in North America.

Lamp

A generic term for an electric source of light. A lamp usually consists of a light-generating element (arc tube or filament), support hardware, enclosing envelope and base.

Light

Any radiation which makes things visible. It is radiant electromagnetic energy capable of exciting the retina of the eye and producing a visual sensation.

Lumen (lm)

The unit of luminous flux, i.e. the quantity of light emitted by a lamp:

1 lumen = 1 candela, x 1 steradian.

Luminaire

A complete lighting unit consisting of a lamp(s) and parts designed to distribute the light, to position and protect the lamp(s) and to connect the lamp(s) to the power supply.

Luminance

The luminous intensity of a surface in a given direction per unit of projected area. The unit for luminance is NIT = candela/m^2 of foot-lambert = ρ candela / ft^2. A surface emitting or reflecting light in a given direction at a rate of one candela per square meter of projected area has a luminance in that direction of 1 cd/m^2 or 1 NIT.

Luminous Exitance

The light leaving a surface at a point is measured in lumens per square foot.

LUX (lx)

A unit of illuminance or lighting level equal to one lumen uniformly falling on an area of one square meter.

Photometer (light meter)

An instrument for measuring photometric quantities such as illuminance (in foot candles or LUX). The light sensitive cell, typically a selenium cell, must be consine corrected and Vλ corrected.

Reflectance

The ratio of light emitted from a surface to the light falling on that surface.

Refraction

The bending of light rays as they pass through clear glass or plastic.

Specular Surface

Surfaces from which the reflection is predominantly regular, e.g., highly polished or mirror finished surfaces.

Transmittance

The ratio of light transmitted through a light-passing material (e.g. glass or ceramics) to the incident light falling on that material.

ELECTRICAL SYMBOL LEGEND

NOTE: DEVICES SHOWN DASHED ARE TO BE REMOVED UNDER THIS CONTRACT

	SURFACE MOUNTED FLUORESCENT, NOMINAL SIZE 1'x4'
	SURFACE MOUNTED FLUORESCENT, NOMINAL SIZE 2'x4'
	RECESSED FLUORESCENT, NOMINAL SIZE 1'x4'
	RECESSED FLUORESCENT, NOMINAL SIZE 2'x4'
	RECESSED FLUORESCENT, NOMINAL SIZE 1'x2' & 2'x2' SHOWN RESPECTIVELY
	PENDANT OR STEM MOUNTED FLUORESCENT
	FLUORESCENT WITH DEEP-CELL PARABOLIC LENS
	WALL MOUNTED FLUORESCENT WALLWASHER
	SINGLE LAMP STRIP OR INDUSTRIAL
	2-LAMP STRIP OR INDUSTRIAL
	SINGLE LAMP STRIP OR INDUSTRIAL, CHAIN OR STEM MOUNTED
	2-LAMP STRIP OR INDUSTRIAL, CHAIN OR STEM MOUNTED
	SHADING DENOTES LUMINAIRE ON 24HR EMERGENCY CIRCUIT
M4	MASTER FIXTURE WITH 4-LAMP BALLAST OPERATING 2,3, OR 4 LAMPS AS SHOWN. LOCATION OF MASTERS CAN BE MOVED TO SUIT SITE CONDITIONS
M2	MASTER FIXTURE WITH 2-LAMP BALLAST OPERATING 1 OR 2 LAMPS AS SHOWN. LOCATION OF MASTERS CAN BE MOVED TO SUIT SITE CONDITIONS
S	SLAVE FIXTURE (NO BALLAST)
F	WALL MOUNTED LUMINAIRE, 'F' DENOTES COMPACT FLUORESCENT, 'H' DENOTES HID, NO LETTER DENOTES INCANDESCENT
F	SURFACE MOUNTED DIRECTIONAL LUMINAIRE, 'F' DENOTES COMPACT FLUORESCENT, 'H' DENOTES HID, NO LETTER DENOTES INCANDESCENT
F	SURFACE CEILING MOUNTED LUMINAIRE, 'F' DENOTES COMPACT FLUORESCENT, 'H' DENOTES HID, NO LETTER DENOTES INCANDESCENT
	SUSPENDED LUMINAIRE, 'F' DENOTES COMPACT FLUORESCENT, 'H' DENOTES HID, NO LETTER DENOTES INCANDESCENT
R	RECESSED LUMINAIRE, 'F' DENOTES COMPACT FLUORESCENT, 'H' DENOTES HID, NO LETTER DENOTES INCANDESCENT
	TRACK MOUNTED DIRECTIONAL LUMINAIRES, 'F' DENOTES COMPACT FLUORESCENT, 'H' DENOTES HID, NO LETTER DENOTES INCANDESCENT
D	DIMMER SWITCH TO BE RE-USED. MAKE CHANGES ONLY AS NOTED
$ / $	LIGHT SWITCH TO BE RE-USED. 120V / 347V SYMBOLS SHOWN RESPECTIVELY. MAKE CHANGES ONLY AS NOTED
$ 3	LOW-VOLTAGE RELAY CONTROL SWITCH. NUMERICAL SYMBOL DENOTES AMOUNT OF SWITCHES IN GANG
$a a	IF CLARIFICATION IS REQUIRED, LOWER CASE LETTER NEXT TO LUMINAIRE DENOTES CORRESPONDING CONTROLLING SWITCH.
$ / $	MOTION SENSOR SWITCH. CEILING-MOUNTED / WALL-MOUNTED SYMBOLS SHOWN RESPECTIVELY
	EMERGENCY LIGHT HEADS. REMOTE / 'SELF-CONTAINED BATTERY PACK' SYMBOLS SHOWN RESPECTIVELY
E / E	EMERGENCY EXIT SIGNS. CEILING-MOUNTED / WALL-MOUNTED SYMBOLS SHOWN RESPECTIVELY
DW	DENOTES DRYWALL CEILING. IF NO 'DW' SYMBOL IS PRESENT, ASSUME CEILING IS SUSPENDED (T-BAR).
101	DENOTES LUMINAIRE TYPE

NOTE: LUMINAIRE SYMBOLS ADHERE TO ANSI/IESNA DESIGN GUIDE #DG-3-00

Page Setup - GRADE

Page setup

Name: <None>

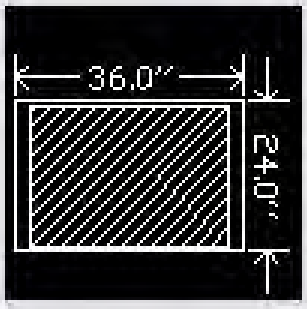
Printer/plotter

Name: None Properties

Plotter: None

Where: Not applicable

Description: The layout will not be plotted unless a new plotter configuration name is selected.



Paper size

ARCH D (36.00 x 24.00 Inches)

Plot area

What to plot:

Extents

Plot offset (origin set to printable area)

X: [illegible] inches Center the plot

Y: [illegible] inch

Plot scale

Fit to paper

Scale: Custom

1 inch =

[illegible] units

Scale lineweights

Plot style table (pen assignments)

acad.ctb

Display plot styles

Shaded viewport options

Shade plot As displayed

Quality Normal

DPI

Plot options

Plot object lineweights

Plot with plot styles

Plot paperspace last

Hide paperspace objects

Drawing orientation

Portrait

Landscape

Plot upside-down

Preview...

OK Cancel Help

DRAWING AND TITLE BLOCK INSTRUCTIONS FOR CAPITAL RENOVATION AND MAJOR CAPITAL CONSTRUCTION PROJECTS

Item#1 GENERAL

All drawing should be done in model space using any convenient standard imperial or metric measurement unit. The title block should reside in paper space. Plotting should be done in paper space using any convenient standard imperial or metric scale(s). Use Architectural A1 (24" x 36") paper for renovation projects or Architectural A-0 (36" x 48") paper for major capital construction projects.

Item#2 GENERAL LAYOUT

The space between the consultant and drawing identification sections may be used for a key plan, symbol legend, or to expand issue and revision records. When Sub-Consultants are involved on a project the sub consultant's logo(s) and stamp(s) are to be located in this area. The size of the logo and stamp are to be equal in size to the prime consultant.

Item#3 CAD FILE SPECIFICATIONS FOR CONSULTANTS

Download the CAD File Specifications from www.uofaweb.ualberta.ca/pi/

Item#4 CONSULTANT BLOCK

This block is the location for the corporate logo and visual identity of the firm responsible for the design drawing.

Item#5 SEAL BLOCK

This block is the location where seals of the profesional members (architects and engineers) responsible for the design of the drawing place their stamps/seals and sign over the affixed stamps/seals.

Item#6 PERMIT BLOCK

This block is the location where Permits to Practice issued by Alberta Architects Association and/or Association of Professional Engineers, Geologist and Geophysicists of Alberta are affixed on the drawing.

Item#7 DRAWING ISSUE BLOCK

A INTERNAL ISSUES

. An internal issue is defined as an issue within the design office.
. The reason for an internal issue shall be clearly displayed on the print. (ie PRELIMINARY, FOR INFORMATION ONLY).
. All internal issues must display the date of the current plot, the drawing number and the reason for an internal issue.
. No entry is made in either the ISSUE block or the REVISION block for an internal plot.

B EXTERNAL ISSUES

. An external issue is defined as an issue to parties outside the design office.
. The reasons for an external issue are typicllly for specific puposes including client review, safety code review, tendering etc.
. External issues are coded in ALPHABETICAL ORDER starting with issue "A". The reason for issue shall be filled in, dated, along with the initials of the individual authorizing issuance. The reason for issue shall be clearly displayed on the print (ie CURRENT REVIEW, TENDER, CONSTRUCTION).
. Any revisions must be updated subsequent to the drawing issued for tender in both the Issue Block as well as in the Issue Letter, next to the drawing number.

Item#8 DRAWING REVISION BLOCK

. This block records changes or additions to the technical information on the drawing.
. Prior to a drawing being issued for tender the drawing revision number will remain zero "0".
. When a drawing is issued for tender the drawing revision will remain zero "0".
. The first issue of a drawing after the drawing has been issued for tender where changes have been recorded in the REVISION BLOCK will be issued as REVISION 1.
Upon every subsequent issue the revision number will be increased both in the REVISION BLOCK as well as in the REVISION NUMBER next to the drawing number.
All technical changes or additions issued shall be clearly marked by placing a triangular flag adjacent to the spot where the change was made.

Item#9 FACULTY/DEPARTMENT

This block identifies the specific faculty and department for which the design work is authorized.

Item#10 BUILDING NAME

This University building name is assigned by the University of Alberta Department of Capital Programs Design Group.

Item#11 JOB NUMBER

This alpha numeric number is assigned by the University of Alberta Capital Programs Office once a design activity is funded and authorized.

Item#12 WORK ORDER NUMBER

The work oreder number is assigned by the University of Alberta Capital Programs Office to authorize the design work reflected on the drawing.

Item#13 UNIVERSITY DRAWING NUMBER

. The initial file (5) digit number is a unique number established for each new or existing building on campus.
This university building number is assigned by the Project Management Office Design Group.
. The subsequent three (3) digit number is assigned by the Project Management Office Design Group to uniquely identify the project.

Item#14 PRIME CONSULTANT DRAWING NUMBER

The drawing number block is set up by the Prime Consultant in accordance with the consultant's drawing control system.
All drawings will be established within the control system identified by a code letter defining the drawing subject and a number series defining the drawing type.

Code	Subject
A	Architectural
C	Civil
M	Mechanical
E	Electrical

Number Series	Drawing type
000	Index, Title Sheet, Legend, Notes
100	Single and Three Line Diagrams
200	Site Plans
300	Building and Area Layouts, Plans, Elevations
400	General Details, Panels
500	Schematics
700	Schedules
800	Miscellaneous
900	Data Sheets

NORTH

Note to all users:
All text, lines and entities on this (red) layer are for user information only and are to be deleted, including the layer on which they reside (layer: "Delete this layer") Subsequently, purge block "Delete" and text style "Delete".

Consultant

Consultant's Seal

Consultant's Permit

UNIVERSITY OF ALBERTA
PLANNING AND INFRASTRUCTURE
TECHNICAL SERVICES
4-80 General Services Building, University of Alberta
Edmonton, Alberta T6G 2H1

Issue

Letter	Date	By	Description
A	2002.09.25	NAME	ISSUED FOR TENDER/ CONSTRUCTION
B			
C			
D			

Revision

Number	Date	By	Description
1	2002.09.25	NAME	DESCRIPTION
2			
3			
4			

Faculty/Department **FACULTY OR DEPARTMENT**

Client Approval Date

Dwg Title **DRAWING/TITLE1**
DRAWING/TITLE2
DRAWING DESCRIPTION

Building **BUILDING NAME**

Job Number **E1234** Work Order Number **90210**

Arch ■ Mech □ Elect □ Strct □ Drawn By **JOE TECH**

Dwg. Created **2003.03.00** Issue **A** Revision **0**
Design File No. **55555-03-0**

Sheet **1 of 1** University Dwg Num **55555 - 999**

consultant project number + A-000

Discipline: Electrical

Model File Type: Lighting Plan

Level #	Level/Layer Naming			Graphics			
	AIA Format	ISO Format	Level/Layer Description	Line Style	Line Width (mm)	AutoCAD Line Color/#	MicroStation Line Color/#
General Information							
1	E-ANNO-DIMS	E-----DIP-	Witness/extension lines, dimension terminators, dimension text	0	V	V	V
2	E-ANNO-KEYN	E-----KEP-	Reference keynotes with associated leaders	0	V	V	V
3	E-ANNO-NPLT	E-----NPP-	Non-plotting graphic information	V	0.18	B/5	B/1
4	E-ANNO-PATT	E-----PAP-	Miscellaneous patterning and hatching	0	0.18	Gr/8	Gr/9
5	E-ANNO-NOTE	E-----NOP-	General notes and general remarks	0	0.35	Y/2	Y/4
6	E-ANNO-SYMB	E-----SYP-	Miscellaneous symbols	V	0.35	M/6	M/5
7	E-ANNO-TEXT	E-----TEP-	Miscellaneous text and callouts with associated leaders	0	V	V	V
NA	E-ANNO-REFR	E-----RFP-	Reference files (AutoCAD users only, see Chapter 4)	NA	NA	NA	NA
Floor Information							
8	E-FLOR-IDEN	E-FLORIDM-	Room name, space identification text (copied from Architectural - Floor Plan model file)	0	0.25	G/3	G/2
9	E-FLOR-NUMB	E-FLORNUM-	Room/space identification number and symbol (copied from Architectural - Floor Plan model file)	0	0.25	G/3	G/2
Electrical Equipment							
10	E-LITE-PANL	E-LITEPAM-	Main distribution panels, switchboards, lighting panels	0	0.50	C/4	C/7
Junction Boxes							
14	E-LITE-JBOX	E-LITEJBM-	Junction boxes	0	0.50	83	42
Switches							
16	E-LITE-SWCH	E-LITESWM-	Lighting contactors, photoelectric controls, low-voltage lighting controls, etc.	0	0.50	163	41
Lighting							
18	E-LITE-CLNG	E-LITECLM-	Ceiling mounted (surface/pendant) fixtures	0	0.50	203	45
19	E-LITE-EMER	E-LITEEMM-	Emergency fixtures (outline of light (if ceiling mounted) should go on E-LITE-CLNG)	0	0.50	23	46
20	E-LITE-EXIT	E-LITEEXM-	Exit fixtures (outline of light (if ceiling mounted) should go on E-LITE-CLNG)	0	0.50	203	45
21	E-LITE-FLOR	E-LITEFLM-	Floor mounted fixtures (e.g., stage)	0	0.50	203	45
22	E-LITE-IDEN	E-LITEIDM-	Light fixture identifier tags	0	0.35	Y/2	Y/4
24	E-LITE-ROOF	E-LITEROM-	Roof lighting	0	0.50	203	45
26	E-LITE-SPCL	E-LITESPM-	Special fixtures	0	0.50	203	45
27	E-LITE-WALL	E-LITEWAM-	Wall mounted fixtures	0	0.50	203	45
Circuit Lines							
47	E-LITE-CIRC	E-LITECIM-	Lighting circuits (including crosslines and homeruns)	0	0.50	83	42
48	E-LITE-CIRC-NUMB	E-LITECNM-	Lighting circuit numbers (e.g., panel/circuit number, wire/conduit size)	0	0.35	Y/2	Y/4
Demolition (used only in creating Existing/Demolition model files)							
56	E-STAT-DEMO-PHS1	E-------M-D----1	Demolition - phase 1	0	0.50	203	45
57	E-STAT-DEMO-PHS2	E-------M-D----2	Demolition - phase 2	0	0.50	83	42
58	E-STAT-DEMO-PHS3	E-------M-D----3	Demolition - phase 3	0	0.50	163	41
Other Discipline Information							
60	E-DISC-INFO	E-DISCINM-	Clearances and working space information (NEC code, etc.)	0	0.25	G/3	G/2

Note: V = Varies, NA = Not Applicable

Discipline: Electrical

Model File Type: Power Plan

Level #	Level/Layer Naming		Level/Layer Description	Graphics			
	AIA Format	ISO Format		Line Style	Line Width (mm)	AutoCAD Line Color/#	MicroStation Line Color/#
General Information							
1	E-ANNO-DIMS	E-----DIP-	Witness/extension lines, dimension terminators, dimension text	0	V	V	V
2	E-ANNO-KEYN	E-----KEP-	Reference keynotes with associated leaders	0	V	V	V
3	E-ANNO-NPLT	E-----NPP-	Non-plotting graphic information	V	0.18	B/5	B/1
4	E-ANNO-PATT	E-----PAP-	Miscellaneous patterning and hatching	0	0.18	Gr/8	Gr/9
5	E-ANNO-NOTE	E-----NOP-	General notes and general remarks	0	0.35	Y/2	Y/4
6	E-ANNO-SYMB	E-----SYP-	Miscellaneous symbols	V	0.35	M/6	M/5
7	E-ANNO-TEXT	E-----TEP-	Miscellaneous text and callouts with associated leaders	0	V	V	V
NA	E-ANNO-REFR	E-----RFP-	Reference files (AutoCAD users only, see Chapter 4)	NA	NA	NA	NA
Floor Information							
8	E-FLOR-IDEN	E-FLORIDM-	Room name, space identification text (copied from Architectural - Floor Plan model file)	0	0.25	G/3	G/2
9	E-FLOR-NUMB	E-FLORNUM-	Room/space identification number and symbol (copied from Architectural - Floor Plan model file)	0	0.25	G/3	G/2
Electrical Equipment							
10	E-POWR-PANL	E-POWRPAM-	Panelboards, switchboards, MCC, unit substations	0	0.50	C/4	C/7
Junction Boxes							
14	E-POWR-JBOX	E-POWRJBM-	Junction boxes	0	0.50	83	42
Switches							
16	E-POWR-SWCH	E-POWRSWM-	Disconnect switches, motor starters, contactors, etc	0	0.50	163	41
Power							
18	E-POWR-BUSW	E-POWRBUM-	Busways and wireways	0, BUSWAY, WIREWY	0.50	203	45
19	E-POWR-CABL	E-POWRCAM-	Cable trays	0	0.50	203	45
20	E-POWR-CLNG	E-POWRCLM-	Ceiling outlets (receptacles and switches)	0	0.50	83	42
21	E-POWR-FEED	E-POWRFEM-	Feeders	0	0.50	203	45
24	E-POWR-URAC	E-POWRURM-	Underfloor raceways	3	0.50	203	45
25	E-POWR-WALL	E-POWRWAM-	Wall/floor outlets (receptacles and switches)	0	0.50	83	42
Motors/Generators							
27	E-POWR-MOTR	E-POWRMOM-	Motors and utilization equipment	0	0.50	C/4	C/7
28	E-POWR-GENR	E-POWRGEM-	Generators and auxiliary equipment	0	0.50	C/4	C/7
Circuit Lines							
47	E-POWR-CIRC	E-POWRCIM-	Power circuits (including crosslines and homeruns)	V	0.50	83	42
48	E-POWR-CIRC-NUMB	E-POWRCNM-	Power circuit numbers (e.g., panel/circuit number, wire/conduit size	0	0.35	Y/2	Y/4
Demolition (used only in creating Existing/Demolition model files)							
56	E-STAT-DEMO-PHS1	E-------M-D----1	Demolition - phase 1	0	0.50	203	45
57	E-STAT-DEMO-PHS2	E-------M-D----2	Demolition - phase 2	0	0.50	83	42
58	E-STAT-DEMO-PHS3	E-------M-D----3	Demolition - phase 3	0	0.50	163	41
Other Discipline Information							
60	E-DISC-INFO	E-DISCINM-	Clearances and working space information (NEC code, etc.)	0	0.25	G/3	G/2

Note: V = Varies, NA = Not Applicable

Discipline: Electrical

Model File Type: Special Systems Plan

Level #	Level/Layer Naming		Level/Layer Description	Graphics			
	AIA Format	ISO Format		Line Style	Line Width (mm)	AutoCAD Line Color/#	MicroStation Line Color/#
General Information							
1	E-ANNO-DIMS	E-----DIP-	Witness/extension lines, dimension terminators, dimension text	0	V	V	V
2	E-ANNO-KEYN	E-----KEP-	Reference keynotes with associated leaders	0	V	V	V
3	E-ANNO-NPLT	E-----NPP-	Non-plotting graphic information	V	0.18	B/5	B/1
4	E-ANNO-PATT	E-----PAP-	Miscellaneous patterning and hatching	0	0.18	Gr/8	Gr/9
5	E-ANNO-NOTE	E-----NOP-	General notes and general remarks	0	0.35	Y/2	Y/4
6	E-ANNO-SYMB	E-----SYP-	Miscellaneous symbols	V	0.35	M/6	M/5
7	E-ANNO-TEXT	E-----TEP-	Miscellaneous text and callouts with associated leaders	0	V	V	V
NA	E-ANNO-REFR	E-----RFP-	Reference files (AutoCAD users only, see Chapter 4)	NA	NA	NA	NA
Floor Information							
8	E-FLOR-IDEN	E-FLORIDM-	Room name, space identification text (copied from Architectural - Floor Plan model file)	0	0.25	G/3	G/2
9	E-FLOR-NUMB	E-FLORNUM-	Room/space identification number and symbol (copied from Architectural - Floor Plan model file)	0	0.25	G/3	G/2
Electrical Equipment							
10	E-SPCL-PANL	E-SPCLPAM-	Panelboards, backing boards, patch panel racks	0	0.50	C/4	C/7
Junction Boxes							
14	E-SPCL-JBOX	E-SPCLJBM-	Junction boxes	0	0.50	83	42
Bell System							
16	E-BELL-IDEN	E-BELLIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
17	E-BELL-SYMB	E-BELLSYM-	Bell system symbols	0	0.50	203	45
Central Dictation System							
18	E-DICT-IDEN	E-DICTIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
19	E-DICT-SYMB	E-DICTSYM-	Central dictation system symbols	0	0.50	203	45
Clock System							
20	E-CLOK-IDEN	E-CLOKIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
21	E-CLOK-SYMB	E-CLOKSYM-	Clock system symbols	0	0.50	203	45
Miscellaneous Alarm System							
22	E-ALRM-IDEN	E-ALRMIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
23	E-ALRM-SYMB	E-ALRMSYM-	Miscellaneous alarm system symbols	0	0.50	203	45
Nurse Call/Paging Systems							
24	E-NURS-IDEN	E-NURSIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
25	E-NURS-SYMB	E-NURSSYM-	Nurse call/paging system symbols	0	0.50	203	45
Sound System							
26	E-SOUN-IDEN	E-SOUNIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
27	E-SOUN-SYMB	E-SOUNSYM-	Sound system symbols	0	0.50	203	45
Cable TV System							
28	E-CATV-IDEN	E-CATVIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
29	E-CATV-SYMB	E-CATVSYM-	Cable television system symbols	0, CABLTV	0.50	203	45
Closed-Circuit Television System							
30	E-CCTV-IDEN	E-CCTVIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
31	E-CCTV-SYMB	E-CCTVSYM-	Closed-circuit television system symbols	0	0.50	203	45
TV Antenna System							
32	E-TVAN-IDEN	E-TVANIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
33	E-TVAN-SYMB	E-TVANSYM-	TV antenna system symbols	0	0.50	203	45
Intercom/Public Address System							
34	E-INTC-IDEN	E-INTCIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
35	E-INTC-SYMB	E-INTCSYM-	Intercom/PA system symbols	0	0.50	203	45
Energy Monitoring Control Systems							
36	E-EMCS-IDEN	E-EMCSIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
37	E-EMCS-SYMB	E-EMCSSYM-	Energy monitoring control system symbols	0	0.50	203	45
Security System							
38	E-SERT-IDEN	E-SERTIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
39	E-SERT-ACCS	E-SERTACM-	Access control system symbols	0	0.50	23	46
40	E-SERT-UNDR	E-SERTUNM-	Buried sensors	0	0.50	23	46
41	E-SERT-CLNG	E-SERTCLM-	Ceiling mounted sensors	0	0.50	23	46
42	E-SERT-FLOR	E-SERTFLM-	Floor mounted sensors	0	0.50	23	46
43	E-SERT-WALL	E-SERTWAM-	Wall mounted sensors	0	0.50	23	46

Discipline: Electrical

Model File Type: Special Systems Plan

Cable System							
50	E-CABL-COAX	E-COMMCOM-	Coax cable	2	0.50	83	42
51	E-CABL-FIBR	E-COMMFIM-	Fiber optics cable	FIBOPT	0.50	83	42
52	E-CABL-IDEN	E-COMMIDM-	Cable identifiers	0	0.35	Y/2	Y/4
53	E-CABL-MULT	E-COMMMUM-	Multi-conductor cable	V	0.50	83	42
54	E-CABL-TRAY	E-COMMTRM-	Cable trays and wireways	0	0.50	203	45
Demolition (used only in creating Existing/Demolition model files)							
56	E-STAT-DEMO-PHS1	E-------M-D----1	Demolition - phase 1	0	0.50	203	45
57	E-STAT-DEMO-PHS2	E-------M-D----2	Demolition - phase 2	0	0.50	83	42
58	E-STAT-DEMO-PHS3	E-------M-D----3	Demolition - phase 3	0	0.50	163	41
Other Discipline Information							
60	E-DISC-INFO	E-DISCINM-	Clearances and working space information (NEC code, etc.)	0	0.25	G/3	G/2

Note: V = Varies, NA = Not Applicable

Discipline: Electrical

Model File Type: Grounding System Plan

Level #	Level/Layer Naming		Level/Layer Description	Graphics			
	AIA Format	ISO Format		Line Style	Line Width (mm)	AutoCAD Line Color/#	MicroStation Line Color/#
General Information							
1	E-ANNO-DIMS	E-----DIP-	Witness/extension lines, dimension terminators, dimension text	0	V	V	V
2	E-ANNO-KEYN	E-----KEP-	Reference keynotes with associated leaders	0	V	V	V
3	E-ANNO-NPLT	E-----NPP-	Non-plotting graphic information	V	0.18	B/5	B/1
4	E-ANNO-PATT	E-----PAP-	Miscellaneous patterning and hatching	0	0.18	Gr/8	Gr/9
5	E-ANNO-NOTE	E-----NOP-	General notes and general remarks	0	0.35	Y/2	Y/4
6	E-ANNO-SYMB	E-----SYP-	Miscellaneous symbols	V	0.35	M/6	M/5
7	E-ANNO-TEXT	E-----TEP-	Miscellaneous text and callouts with associated leaders	0	V	V	V
NA	E-ANNO-REFR	E-----RFP-	Reference files (AutoCAD users only, see Chapter 4)	NA	NA	NA	NA
Ground System							
33	E-GRND-CIRC	E-GRNDCIM-	Circuits	0	0.50	C/4	C/7
34	E-GRND-DIAG	E-GRNDDIM-	Ground system diagram	0	0.50	163	41
35	E-GRND-EQUI	E-GRNDEQM-	Equipotential ground system	0	0.50	83	42
36	E-GRND-REFR	E-GRNDREM-	Reference ground system	0	0.50	23	46
Lightning Protection System							
38	E-LTNG-COND	E-LTNGCOM-	Lightning protection conductors	0	0.50	203	45
39	E-LTNG-TERM	E-LTNGTEM-	Lightning protection terminals	0	0.50	203	45
Demolition (used only in creating Existing/Demolition model files)							
56	E-STAT-DEMO-PHS1	E-------M-D----1	Demolition - phase 1	0	0.50	203	45
57	E-STAT-DEMO-PHS2	E-------M-D----2	Demolition - phase 2	0	0.50	83	42
58	E-STAT-DEMO-PHS3	E-------M-D----3	Demolition - phase 3	0	0.50	163	41

Note: V = Varies, NA = Not Applicable

Discipline: Electrical

Model File Type: Electrical Utilities Plan

Level #	Level/Layer Naming		Level/Layer Description	Graphics			
	AIA Format	ISO Format		Line Style	Line Width (mm)	AutoCAD Line Color/#	MicroStation Line Color/#
General Information							
1	E-ANNO-DIMS	E-----DIP-	Witness/extension lines, dimension terminators, dimension text	0	V	V	V
2	E-ANNO-KEYN	E-----KEP-	Reference keynotes with associated leaders	0	V	V	V
3	E-ANNO-NPLT	E-----NPP-	Non-plotting graphic information	V	0.18	B/5	B/1
4	E-ANNO-PATT	E-----PAP-	Miscellaneous patterning and hatching	0	0.18	Gr/8	Gr/9
5	E-ANNO-NOTE	E-----NOP-	General notes and general remarks	0	0.35	Y/2	Y/4
6	E-ANNO-SYMB	E-----SYP-	Miscellaneous symbols	V	0.35	M/6	M/5
7	E-ANNO-TEXT	E-----TEP-	Miscellaneous text and callouts with associated leaders	0	V	V	V
NA	E-ANNO-REFR	E-----RFP-	Reference files (AutoCAD users only, see Chapter 4)	NA	NA	NA	NA
Primary Electrical Cables							
11	E-PRIM-OVHD	E-PRIMOVM-	Overhead electrical utility lines	EPARN	0.50	C/4	C/7
12	E-PRIM-OVHD-IDEN	E-PRIMOIM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
13	E-PRIM-UNDR	E-PRIMUNM-	Underground electrical utility lines	EPUGN	0.50	C/4	C/7
14	E-PRIM-UNDR-IDEN	E-PRIMUIM-	Identifier tags, symbol modifier, and tex	0	0.35	Y/2	Y/4
Secondary Electrical Cables							
15	E-SECD-OVHD	E-SECDOVM-	Overhead electrical utility lines	ESARN	0.50	163	41
16	E-SECD-OVHD-IDEN	E-SECDOIM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
17	E-SECD-UNDR	E-SECDUNM-	Underground electrical utility lines	ESUGN	0.50	163	41
18	E-SECD-UNDR-IDEN	E-SECDUIM-	Identifier tags, symbol modifier, and tex	0	0.35	Y/2	Y/4
Transformers							
19	E-TRAN-PADM	E-TRANPAM-	Pad mounted transformers	0	0.50	23	46
20	E-TRAN-PADM-IDEN	E-TRANPDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
21	E-TRAN-POLE	E-TRANPOM-	Pole mounted transformers	0	0.50	23	46
22	E-TRAN-POLE-IDEN	E-TRANPIM-	Identifier tags, symbol modifier, and tex	0	0.35	Y/2	Y/4
Electrical Support Equipment							
23	E-ELEC-JBOX	E-ELECJBM-	Junction boxes, pull boxes, manholes, handholes, pedestals, splices	0	0.50	23	46
24	E-ELEC-DEVC	E-ELECDEM-	Capacitors, voltage regulators, motors, buses, generators, meters, grounds, and markers	0	0.50	23	46
25	E-ELEC-SWCH	E-ELECSWM-	Fuse cutouts, pole mounted switches, circuit breakers, gang operated disconnects, reclosers, cubicle switches	0	0.50	23	46
26	E-ELEC-SUBS	E-ELECSUM-	Other substation equipmen	0	0.50	23	46
Lights							
31	E-LITE-EXTR	E-LITEFXM-	Exterior lights	0	0.50	203	45
32	E-LITE-EXTR-IDEN	E-LITEFIM-	Identifier tags, symbol modifier, and tex	0	0.35	Y/2	Y/4
Utility Poles							
33	E-POLE-UTIL	E-POLEUTM-	Utility poles	0	0.50	203	45
34	E-POLE-IDEN	E-POLEUIM-	Utility pole identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
35	E-POLE-GUYS	E-POLEGYM-	Guying equipment	0	0.50	203	45
36	E-POLE-GUYS-IDEN	E-POLEGIM-	Guying equipment identifier tags, symbol modifiers, and tex	0	0.35	Y/2	Y/4
Underground Ductbanks (to be used when multiple systems are in one ductbank system)							
37	E-DUCT-MULT	E-DUCTMUM-	Ductbank	EUDUCN	0.50	83	42
38	E-DUCT-MULT-IDEN	E-DUCTMIM-	Identifier tags, symbol modifier and tex	0	0.35	Y/2	Y/4
Cathodic Protection System							
40	E-CATH-ANOD	E-CATHANM-	Sacrificial anode system	0	0.50	83	42
41	E-CATH-CURR	E-CATHCUM-	Impress current system	0	0.50	83	42
42	E-CATH-TEST	E-CATHTEM-	Test stations	0	0.50	83	42
43	E-CATH-IDEN	E-CATHIDM-	Identifier tags, symbol modifier, and tex	0	0.35	Y/2	Y/4
Special Systems							
45	E-SPCL-TRAF	E-SPCLTRM-	Traffic signal system	0	0.50	203	45
46	E-SPCL-TRAF-IDEN	E-SPCLTIM-	Traffic signal identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
47	E-SPCL-SYST	E-SPCLSYM-	Special systems (UMCS, EMCS, CATV, etc.)	0	0.50	203	45
48	E-SPCL-IDEN	E-SPCLIDM-	Special systems (UMCS, EMCS, CATV, etc.) identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4

Discipline: Electrical

Model File Type: Electrical Utilities Plan

Demolition (used only in creating Existing/Demolition model files)							
56	E-STAT-DEMO-PHS1	E-------M-D----1	Demolition - phase 1	0	0.50	203	45
57	E-STAT-DEMO-PHS2	E-------M-D----2	Demolition - phase 2	0	0.50	83	42
58	E-STAT-DEMO-PHS3	E-------M-D----3	Demolition - phase 3	0	0.50	163	41
Other Discipline Information							
60	E-DISC-INFO	E-DISCINM-	Clearances and working space information (NEC code, etc.)	0	0.25	G/3	G/2

Note: V = Varies, NA = Not Applicable

Discipline: Electrical

Model File Type: Exterior Communication Systems Plan

Level #	Level/Layer Naming		Level/Layer Description	Graphics			
	AIA Format	ISO Format		Line Style	Line Width (mm)	AutoCAD Line Color/#	MicroStation Line Color/#
General Information							
1	E-ANNO-DIMS	E-----DIP-	Witness/extension lines, dimension terminators, dimension text	0	V	V	V
2	E-ANNO-KEYN	E-----KEP-	Reference keynotes with associated leaders	0	V	V	V
3	E-ANNO-NPLT	E-----NPP-	Non-plotting graphic information	V	0.18	B/5	B/1
4	E-ANNO-PATT	E-----PAP-	Miscellaneous patterning and hatching	0	0.18	Gr/8	Gr/9
5	E-ANNO-NOTE	E-----NOP-	General notes and general remarks	0	0.35	Y/2	Y/4
6	E-ANNO-SYMB	E-----SYP-	Miscellaneous symbols	V	0.35	M/6	M/5
7	E-ANNO-TEXT	E-----TEP-	Miscellaneous text and callouts with associated leaders	0	V	V	V
NA	E-ANNO-REFR	E-----RFP-	Reference files (AutoCAD users only, see Chapter 4)	NA	NA	NA	NA
Communications Cables (Copper and Fiber Optic)							
11	E-COMM-OVHD	E-COMMOVM-	Overhead communications/telephone lines	COMARN	0.50	C/4	C/7
12	E-COMM-OVHD-IDEN	E-COMMOIM-	Identifier tags, symbol modifier and text	0	0.35	Y/2	Y/4
13	E-COMM-UNDR	E-COMMUNM-	Underground communications/telephone lines	COMUGN	0.50	C/4	C/7
14	E-COMM-UNDR-IDEN	E-COMMUIM-	Identifier tags, symbol modifier and tex	0	0.35	Y/2	Y/4
Communications Support Equipment							
23	E-COMM-JBOX	E-COMMJBM-	Communication junction boxes, pull boxes, manholes, handholes, pedestals, splices	0	0.50	23	46
26	E-COMM-EQPM	E-COMMEQM-	Other communications distribution equipmen	0	0.50	23	46
Utility Poles (Use only if different from Existing Electrical Utilities Plan poles)							
33	E-POLE-UTIL	E-POLEUTM-	Poles	0	0.50	203	45
34	E-POLE-IDEN	E-POLEIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
35	E-POLE-GUYS	E-POLEGYM-	Guying equipment	0	0.50	203	45
36	E-POLE-GUYS-IDEN	E-POLEGIM-	Guying equipment identifier tags, symbol modifiers, and tex	0	0.35	Y/2	Y/4
Underground Ductbanks (to be used when multiple systems are in one ductbank system)							
37	E-DUCT-MULT	E-DUCTMUM-	Ductbank	EUDUCN	0.50	83	42
38	E-DUCT-MULT-IDEN	E-DUCTMIM-	Identifier tags, symbol modifier and tex	0	0.35	Y/2	Y/4
Demolition (used only in creating Existing/Demolition model files)							
56	E-STAT-DEMO-PHS1	E-------M-D----1	Demolition - phase 1	0	0.50	203	45
57	E-STAT-DEMO-PHS2	E-------M-D----2	Demolition - phase 2	0	0.50	83	42
58	E-STAT-DEMO-PHS3	E-------M-D----3	Demolition - phase 3	0	0.50	163	41
Other Discipline Information							
60	E-DISC-INFO	E-DISCINM-	Clearances and working space information (NEC code, etc.)	0	0.25	G/3	G/2

Note: V = Varies, NA = Not Applicable

Discipline: Electrical

Model File Type: Airfield Lighting Plan

Level #	Level/Layer Naming		Level/Layer Description	Graphics			
	AIA Format	ISO Format		Line Style	Line Width (mm)	AutoCAD Line Color/#	MicroStation Line Color/#
General Information							
1	E-ANNO-DIMS	E-----DIP-	Witness/extension lines, dimension terminators, dimension text	0	V	V	V
2	E-ANNO-KEYN	E-----KEP-	Reference keynotes with associated leaders	0	V	V	V
3	E-ANNO-NPLT	E-----NPP-	Non-plotting graphic information	V	0.18	B/5	B/1
4	E-ANNO-PATT	E-----PAP-	Miscellaneous patterning and hatching	0	0.18	Gr/8	Gr/9
5	E-ANNO-NOTE	E-----NOP-	General notes and general remarks	0	0.35	Y/2	Y/4
6	E-ANNO-SYMB	E-----SYP-	Miscellaneous symbols	V	0.35	M/6	M/5
7	E-ANNO-TEXT	E-----TEP-	Miscellaneous text and callouts with associated leaders	0	V	V	V
NA	E-ANNO-REFR	E-----RFP-	Reference files (AutoCAD users only, see Chapter 4)	NA	NA	NA	NA
Airfield Lighting Circuits							
11	E-CIRC-SERS	E-CIRCSEM-	Series circuits	0	0.50	203	45
12	E-CIRC-MULT	E-CIRCMUM-	Multiple circuits	0	0.50	23	46
13	E-CIRC-CTRL	E-CIRCCTM-	Control and monitoring circuits	0	0.50	163	41
15	E-CIRC-IDEN	E-CIRCIDM-	Identifier tags, symbol modifier, and tex	0	0.35	Y/2	Y/4
Devices							
20	E-AIRF-DEVC	E-AIRFDEM-	Capacitors, voltage regulators, motors, buses, generators, meters, grounds, and markers	0	0.50	23	46
Junction Boxes							
23	E-AIRF-JBOX	E-AIRFJBM-	Junction boxes, pull boxes, manholes, handholes, pedestals, splice	0	0.50	23	46
Lights							
25	E-LITE-OBST	E-LITEOBM-	Obstruction lights	0	0.50	203	45
26	E-LITE-DIST	E-LITEDIM-	Distance and arresting gear markers	0	0.50	203	45
28	E-LITE-APPR	E-LITEAPM-	Approach lights	0	0.50	203	45
29	E-LITE-THRS	E-LITETHM-	Threshold lights	0	0.50	203	45
30	E-LITE-RUNW	E-LITERUM-	Runway lights	0	0.50	203	45
31	E-LITE-TAXI	E-LITETAM-	Taxiway lights	0	0.50	203	45
32	E-LITE-LANE	E-LITELAM-	Hoverlane, taxilane, and helipad lights	0	0.50	203	45
33	E-LITE-SIGN	E-LITESIM-	Taxiway guidance signs	0	0.50	203	45
Ductbank							
37	E-AIRF-DUCT	E-AIRFDUM-	Ductbanks	EUDUCN	0.50	83	42
Beacons							
42	E-BCNS-IDEN	E-BCNSIDM-	Identifier tags, symbol modifier, and text	0	0.35	Y/2	Y/4
43	E-BCNS-STRB	E-BCNSSTM-	Strobe beacons	0	0.50	203	45
44	E-BCNS-MISC	E-BCNSMIM-	Miscellaneous navaids - windcones and beacons	0	0.50	203	45
Demolition (used only in creating Existing/Demolition model files)							
56	E-STAT-DEMO-PHS1	E-------M-D----1	Demolition - phase 1	0	0.50	203	45
57	E-STAT-DEMO-PHS2	E-------M-D----2	Demolition - phase 2	0	0.50	83	42
58	E-STAT-DEMO-PHS3	E-------M-D----3	Demolition - phase 3	0	0.50	163	41
Other Discipline Information							
60	E-DISC-INFO	E-DISCINM-	Clearances and working space information (NEC code, etc.)	0	0.25	G/3	G/2

Note: V = Varies, NA = Not Applicable

Discipline: Electrical

Model File Type: Details

Level #	Level/Layer Naming		Level/Layer Description	Graphics			
	AIA Format	ISO Format		Line Style	Line Width (mm)	AutoCAD Line Color/#	MicroStation Line Color/#
General Information							
1	E-ANNO-DIMS	E-----DIP-	Witness/extension lines, dimension terminators, dimension text	0	V	V	V
2	E-ANNO-KEYN	E-----KEP-	Keynotes with associated terminators	0	V	V	V
3	E-ANNO-NPLT	E-----NPP-	Non-plotting graphic information	V	0.18	B/5	B/1
4	E-ANNO-PATT	E-----PAP-	Miscellaneous patterning and hatching	0	0.18	Gr/8	Gr/9
5	E-ANNO-NOTE	E-----NOP-	General notes and general remarks	0	0.35	Y/2	Y/4
6	E-ANNO-SYMB	E-----SYP-	Reference bubbles, matchlines and breaklines	0	0.35	M/6	M/5
7	E-ANNO-TEXT	E-----TEP-	Detail title text, text and associated leaders, notes	0	0.35	Y/2	Y/4
Detail Information							
11	E-DETL-GRPH	E-DETLGRM-	Graphics, gridlines, non-text items	V	V	V	V
12	E-DETL-METR	E-DETLMEM-	Metric-specific dimensions and notes	0	0.35	Y/2	Y/4
13	E-DETL-INPD	E-DETLINM-	Inch-pound-specific dimensions and notes	0	0.35	Y/2	Y/4
Other Discipline Information							
60	E-DISC-INFO	E-DISCINM-	Information and notes for other disciplines	V	V	V	V

Note: V = Varies

Discipline: Electrical

Model File Type: Riser/One-Line Diagrams

Level #	Level/Layer Naming		Level/Layer Description	Graphics			
	AIA Format	ISO Format		Line Style	Line Width (mm)	AutoCAD Line Color/#	MicroStation Line Color/#
General Information							
1	E-ANNO-DIMS	E-----DIP-	Witness/extension lines, dimension terminators, dimension text	0	V	V	V
2	E-ANNO-KEYN	E-----KEP-	Keynotes with associated terminators	0	V	V	V
3	E-ANNO-NPLT	E-----NPP-	Non-plotting graphic information	V	0.18	B/5	B/1
4	E-ANNO-PATT	E-----PAP-	Miscellaneous patterning and hatching	0	0.18	Gr/8	Gr/9
5	E-ANNO-NOTE	E-----NOP-	General notes and general remarks	0	0.35	Y/2	Y/4
6	E-ANNO-SYMB	E-----SYP-	Miscellaneous symbols	0	0.35	M/6	M/5
7	E-ANNO-TEXT	E-----TEP-	Miscellaneous text and callouts with associated leaders	0	0.35	Y/2	Y/4
Diagram Information							
11	E-DIAG-GRPH	E-DIAGGRM-	Graphics, gridlines, non-text items	V	V	V	V
12	E-DIAG-METR	E-DIAGMEM-	Metric-specific dimensions and notes	0	0.35	Y/2	Y/4
13	E-DIAG-INPD	E-DIAGINM-	Inch-pound-specific dimensions and notes	0	0.35	Y/2	Y/4
14	E-DIAG-IDEN	E-DIAGIDM-	Identifier tags, symbol modifier and text	0	0.35	Y/2	Y/4
Other Discipline Information							
60	E-DISC-INFO	E-DISCINM-	Information and notes for other disciplines	V	V	V	V

Note: V = Varies

APPROVED LUMINAIRES

APPENDIX D

CATEGORY TYPE	SUB TYPE / DESCRIPTION	MANUFACTURER	MODEL #	Lamps
Halogen Luminaires	**Recessed Downlights**	RITELITE/DASAL	#2-200	Up to 75W MR16
		RITELITE/DASAL	#2-120	Up to 75W MR16
		ZUMTOBEL	MICROS	50W MR16
	Track Mounted Luminaires	JUNO	TF150, TF155, TF170	Up to 50W MR16
			TF180 & TF190	
		HALO	L1763	Up to 50W MR16
		HALO	L1742	Up to 75W MR16
		HALO	L2771	Up to 75W MR16
Linear Fluorescent Luminaires	**Tee Bar 1 x 4**	CUSTOM LIGHTING	Model 402	(1/2)xT8, 1xT5HO
		METALUX	GC Series	(1/2/3)xT8
			with reflector by 3rd party	
		COLUMBIA LTG	4PS14 Series	(1/2/3)xT8, (1/2/3)xT5HO
			with reflector by 3rd party	
		LITHONIA	SP8 Series	(1/2/3)xT8
	Tee Bar 2 x 2	CUSTOM LIGHTING	LS-505, LS-507	(2/3/4)xT8, (2/3/4)xT5HO
		METALUX	GC Series	(2/3/4)xT8
			with reflector by 3rd party	
		COLUMBIA LTG	4PS22 Series	(2/3/4)xT8
			with reflector by 3rd party	
		LITHONIA	2SP8 Series	(2/3/4)xT8
	Tee Bar 2 x 4	LITHONIA	2SP8 Series	(2/3/4)xT8
		CUSTOM LIGHTNIG	CL9R	(2/3/4)xT8, 2xT5HO
	1 x 2 Recessed Tee Bar Video Conferencing	COLUMBIA LTG	VC Series	2xT8
			with reflector by 3rd party	
	Recessed Wall Wash 1 x 4	CUSTOM LIGHTING	LS-708	1xT8, 1xT5HO
		METALUX	RWW Series	(1/2)xT8, 1xT5HO
		PEERLESS	LWR9 Series	1xT8, 1xT5HO
	Recessed Wall Wash 1 x 2	CUSTOM LIGHTING	LS-708-2ft	1xT8, 1xT5HO
		METALUX	RWW Series	(1/2)xT8, 1xT5HO
		COLUMBIA LTG	PW Series	(1/2)xT8, (1/2)xT5HO
			with reflector by 3rd party	
	Recessed Linear	CUSTOM LIGHTING	Model LS - RL	1xT8, 1xT5HO
		NEORAY	79PF / T8 Series	1xT8
		PEERLESS	LSR9 Series	1xT5HO
	Surface Box 1 x 4	CUSTOM LIGHTING	LS-401	(1/2)xT8, 1xT5HO
		METALUX	M Series	(2/3)xT8
			with reflector by 3rd party	
		COLUMBIA LTG	SM14 Series	(2/3)xT8, (2/3)xT5HO
			with reflector by 3rd party	
		LITHONIA	M Series	(1/2/3)xT8
	Surface Box 2 x 2	CUSTOM LIGHTING	LS-505	(2/3/4)xT8, (2/3/4)xT5HO
		METALUX	M Series	(2/3/4)xT8
			with reflector by 3rd party	
		COLUMBIA LTG	SM22 Series	(2/3/4)xT8, (2/3/4)xT5HO
			with reflector by 3rd party	
		LITHONIA	2M Series	(2/3/4)xT8

APPROVED LUMINAIRES

APPENDIX D

CATEGORY TYPE	SUB TYPE / DESCRIPTION	MANUFACTURER	MODEL #	Lamps
	Surface Wrap	CUSTOM LIGHTING	LS-101	(1/2/3)xT8
		METALUX	WS Series	2xT8
		COLUMBIA LTG	PT Series	(1/2)xT8, (1/2)xT5HO
	Surface Parabolic (narrow beam 2' & 4')	CUSTOM LIGHTING	LS-201	1xT8, 1xT5HO
	Teebar Parabolic 1 x 4	METALUX	EP3 Series	(1/2)xT8
		COLUMBIA LTG	P414 Series	(1/2)xT8, (1/2)xT5HO
			with reflector by 3rd party	
		LITHONIA	PM3 Series	(1/2/3)xT8
	Teebar Parabolic 2 x 2	CUSTOM LIGHTING	LS-505, LS-507	(2/3/4)xT8, (2/4)xT5HO
		COLUMBIA LTG	P422-2 Series	2xT8
			with reflector by 3rd party	
	Teebar Recessed Parabolic (narrow beam 1 x 4)	CUSTOM LIGHTING	LS-202	1xT8, 1xT5HO
		COLUMBIA LTG	LSL14 Stack Light	(1/2)xT8, (1/2)xT5HO
			with reflector by 3rd party	
	High Bay Fluorescent	CUSTOM LIGHTING	LS-502	(3/4)xT5HO
			CL-HI5HO	(2/3/4)xT5HO
		REFLEX	APEX Series	4xT5HO
		LITHONIA	FSB Series	(2/3/4/6)xT5HO
	Direct / Indirect	CUSTOM LIGHTING	LS-T5HO-I/D	(1/2)xT5HO
	Industrial	METALUX	ECIM Series	(2/3/4)xT8
		COLUMBIA LTG	KL Series	(2/3/4)xT8, (2/3/4)xT5HO
		LITHONIA	AFST Series	(1/2/3/4)xT8
		CUSTOM LIGHTING	CL-4-M	(2/4)xT8, (2/4)xT5HO
			CL-4-X	1xT5HO
	Wall mounted wedge	CUSTOM LIGHTING	LS-701 to 704	(1/2)xT8, 1xT5HO
	Track Mounted Luminaires	CUSTOM LIGHTING	LS-1003	(1/2)xT5HO
		LIGHTOLIER	9476 Series	(1/2)xT5HO
Compact Fluorescent Luminaires	**Recessed Downlights**	PORTFOLIO	C7032/C7042	(26/32)W CFL
		LIGHTOLIER	8022	(32/42)W CFL
	Downlights	ZUMTOBEL	PANOS Q	(18/26/32)W CFL
		ZUMTOBEL	PANOS A	(18/26/32)W CFL
LED Products	**Downlights**	ZUMTOBEL	2LIGHT MINI	LED
		ZUMTOBEL	2LIGHT	LED
	Valence Lighting	PHILIPS	Affinium LED String	LED
Exit Sign Luminaires	**Exit Signs**	LUMACELL	GRAWAC2R	LED
		LUMACELL	LER450	LED
		LUMACELL	LER460	LED
		LUMACELL	LER2000	LED
Other	**Outdoor Exterior Lighting**	GRANDLITE	SM109	Triple Tube CFL
		GRANDLITE	SM301	Triple Tube CFL
		GRANDLITE	SM302	Triple Tube CFL
		CUSTOM LIGHTING	LS-J12360	CFL
		QL LIGHTING	QL12-354	CFL
		CUSTOM LIGHTING	LS-804	1xT5HO

DESIGN AND CONSTRUCTION STANDARDS AND GUIDELINES

VARIANCE REQUEST

UNIVERSITY OF ALBERTA
Facilities & Operations

Instructions:

1. Complete a separate variance for each request.
2. If a variance is given, this form must be included in any formal submissions to the University, such as the Design Development Report or Pre-Tender Report.
3. Provide full and complete documentation and/or drawings to substantiate the request.
4. The request for variance from the standard must be filed to allow 10 working days for a proper evaluation.
5. If the requestor is not satisfied with the decision, the matter can be appealed to the Vice-President (Facilities and Operations).

Project Name:		Project Number:	
Building Name:		Building Number:	
Faculty or Department:		Variance Number:	
Project Manager		Date Initiated:	

Variance review requested for:

- ☐ Architectural
- ☐ Mechanical
- ☐ Electrical
- ☐ Landscape Maintenance & Construction
- ☐ Utilities
- ☐ RCMS & Security
- ☐ Evironmental Health & Safety
- ☐ Buildings & Grounds Services

Design Guideline/Standard Section:

Requested Variance and Rationale:

Effect of Variance to:

- Project Quality:
- System Reliability:
- Safety:
- Operability:
- Maintainability:
- Project Longevity:
- Life Cycle Cost Analysis:

Identify effect of variance on the following:

	Yes	No		Yes	No
Reduction in Capital Cost	☐	☐	Increased Operating Costs	☐	☐
Impact on Programs	☐	☐	Increased Maintenance Costs	☐	☐
Impact on Research	☐	☐	Measure is Aesthetic Only	☐	☐

Explanation of Risk:

Decision:	☐ Accepted	☐ Accepted Subject To	☐ Not Accepted

University Comments:	

(Only signature applicable to request is required)

	Signature	**Date**
Architectural & Structural (University Architect)		
Mechanical & Electrical (Director, Infrastructure)		
Buildings and Grounds Services (Director, Facilities Management)		
RCMS and Security (Director, Facilities Management)		
Utilities (Director)		
Environmental Health and Safety (Director)		

Variance Request Number: _____